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THE EFFECTS OF EXPRESSIVITY AND FLIGHT TASK ON COCKPIT COMMUNICATION AND RESOURCE MANAGEMENT

Richard S. Jensen
Department of Aviation

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June 1986

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ABSTRACT

This report presents the results of an investigation to develop a methodology for evaluating crew communication behavior on the flight deck and a flight simulator experiment to test the effects of crew member expressivity, as measured by the Personal Attributes Questionnaire, and flight task on crew communication and flight performance. A methodology for coding and assessing flight crew communication behavior as well as a model for predicting that behavior is advanced. Although not enough crews were found to provide valid statistical tests, the results of the study tend to indicate that crews in which the captain has high expressivity perform better than those whose captain is low in expressivity. There appears to be a strong interaction between captains and first officers along the "level of command" dimension of communication. The PAQ appears to identify those pilots who offer disagreements and initiate new subjects for discussion.

BACKGROUND

The need for effective cockpit management is not new to aviation. Crew coordination and effective leadership have long been stressed in multi-person flight crews. However, the need for a training program designed specifically for teaching cockpit management is just now being recognized. At least twelve airlines are conducting some form of management training for pilots. At a recent NASA/Air Force workshop on cockpit management training, many other airlines were in attendance seeking ideas and assistance for the development of such training. Despite this attention, many pilots are reluctant to fully endorse this type of training.

Historically, there are at least three reasons for pilot reluctance to accept management training. Pilots have resisted any suggestion that they consider a threat to their authority on the flight deck. They have also tended to resist ideas that are not clearly measureable by physical evidence. There may also be a tendency among pilots to hold the technical skill of maneuvering the aircraft above their management duties. Thus, while business executives can easily accept such training, pilots are reluctant to accept management training. In this sense, aviation is far behind the business fields.

However, recent airline accidents identifying faulty cockpit management as the cause have focused attention on this problem. During the past fifteen years, there have been at least sixteen airline accidents in which poor cockpit management or communication identified as a contributing factor. These data represent over 60 percent of the airline accidents during this period. Table 1 presents these sixteen accidents.

Table 1. Air Carrier Cockpit Management Related Accidents

United Airlines, 727, Chicago, Dec 8, 1972
Eastern Airlines, L-1011, Miami, Dec 29, 1972
Pan American, Pago Pago, Jan 30, 1974
Eastern Airlines, DC-9, Charlotte, Sept 11, 1974
TWA, 727, Berryville VA, Dec 1, 1974
PanAm and KLM, both 747s, Tenerife, Mar 27, 1977
United Airlines, DC-8, Salt Lake, Dec 18, 1977
National Airlines, Pensacola, May 8, 1978
United Airlines, DC-8, Portland, Dec 28, 1978
Western Airlines, DC-10, Mexico City, Oct 31, 1979
Danair, 727, Tenerife, April 1980
Air Florida, 737, Washington, Jan 13, 1982
Air Illinois, Beech 99, Oct 11, 1983
Avianca Airlines, 747, Madrid 1985
Delta Airlines, L-1011, Dallas, 1985

In recognition of the need for cockpit management training, NASA began a research program in the mid 1970s on this topic. Another important concern at the time was the effect of fatigue on cockpit management. A NASA sponsored flight simulator experiment by Patrick Ruffell-Smith (1979) is generally recognized as the premier study of this topic. In 1979, NASA sponsored a workshop for airline, government, and university people to discuss the problem of cockpit management and focus research efforts in this direction. In 1981, The Ohio State University initiated the biennial symposium on aviation psychology which includes a significant section on cockpit management.

In the airline industry, cockpit management training programs began in 1979 with KLM which developed a comprehensive five-day training program. USAir and United Airlines began training in 1982. The United program has received a great deal of publicity because of the committment of the airline to provide the training to all of its pilots in a short time. They were also motivated by a wavier of some recurrency training requirements, and they received strong ALPA encouragement. At this writing there are some twelve airlines and/or training organizations offering some form of cockpit management training. Most other airlines are considering this training.

What is CRM Training?

It has become a cliche' in the aviation community to say that the role of the pilot has been changed by technology. Formerly, the primary task of the flight crew was manual control of the aircraft and navigation. In modern aircraft much of the actual control manipulation and navigation can be "down-loaded" to the autopilot and flight management computer. The task of managing the flight deck, that has always been a part of the crew's responsibility, is now becoming their primary task. This management task is being called, cockpit resource management (CRM).

One of the keys to good CRM, as in any management position, is communication between crew members. Information must be requested, offered, and/or given freely in a timely way to permit the captain to make accurate effective decisions. It also requires an understanding of communication styles used by other members of the crew for interpretation and determination of the proper emphasis for a response. Finally, it requires an understanding and acceptance of the role and responsibility of each member of the crew to work as a team.

CRM training can and does take many different forms. However, one important aspect to all training of this type is effective communication. Therefore, all CRM training programs use some method to teach effective communication in the cockpit. Most programs also teach pilots various aspects of management,

leadership, interpersonal relationships, the effects of stressors including fatigue, and team or group dynamics.

<u>The Evaluation Development Task</u>

The objective of the present study, which began in 1982, was to determine the effect of pilot fatigue on cockpit communication and resource management. However, because this was the first empirical study designed to systematically examine cockpit communication, the major effort of the program was focused on the development of tools to examine cockpit communication behavior.

CRM evaluation and cockpit communication evaluation, in particular, are challenging tasks. Both are complex human behaviors involving mental activity that cannot be observed directly. People often have well developed mechanisms for disguising the true meaning behind what they are actually saying. To an extent, the objective of CRM training is to break down these mechanisms and teach pilots to communicate on the surface level at all times. However, the evaluation task requires an understanding of communication even at this level.

Although communication behavior can be observed, it is very complex. Various coding techniques have been devised but all must be administered manually. As such they are subject to human interpretation and error. For these reasons pilots are very reluctant to permit the evaluation of their management behavior. The following is a list of additional reasons for the resistance offered by pilots to such evaluations:

1. Pilots generally have strong egos which may be threatened by an examination of their management style.

2. Evaluation of CRM is an additional hurdle for pilots to cross to prove that they are proficient. This will likely be seen as an unwarranted additional Federal regulation.

3. Pilots may fear that because this is not an exact science, there will be an opportunity for a vindictive examiner to offer negatively biased results.

4. CRM evaluation could be considered to be another threat to the job and economic security of pilots.

5. Some pilots fear that the records of the evaluation could be used against them later in their careers.

For these reasons, pilot groups have asked that all evaluation of CRM, including that done for experimental reasons, be done either through the pilot's "self-examination" or through totally de-identified responses from the pilots. United Airlines

goes so far as to erase the video tape of the pilot's LOFT performance in front of the pilot following the debriefing. They will not save the tape even if the pilot wants it. Such limitations make it difficult to determine whether or not CRM training makes any difference.

Literature Review

Why do some cockpits run smoothly with few incidents of endangered safety and others reflect a lack of communication and even open conflict? Shroyer of United Airlines points out that to work in harmony, we must know what we ourselves, are doing and what others are doing in our communications and our management style. Helmreich views instrumentality and expressivity as significant predictors of the process variable of crew coordination. In his 1983 research, he found evidence that personality traits are directly linked to overall flightdeck performance (Helmreich, 1983). Further research will add data on the effects of leader and member personality profiles in the flight crew interactional process. Helmreich later pointed out (1983) that the best captain, one who creates an environment of teamwork, will have high goal and high group orientation. Blake and Mouton (1978) stressed that the most effective management style is associated with a profile encompassing both characteristics.

A review of communication literature and recent CRM research was conducted in search of communication evaluation methodologies. The assessment methodologies used in these basic communications studies may be useful in the development of evaluation procedures for two-person communication behavior that occurs in the cockpit. This literature review has uncovered numerous communcation studies from the social psychology literature (e.g., Rogers and Farace, 1975).

In the development of the Personal Attributes Questionnaire (PAQ) measuring instrumentality and expressivity, Spence and Helmreich (1978) found that, while some personality profiles exhibit predominantly instrumentality (goal orientation) and others predominately expressivity (group orientation), it is possible for an individual to be high in both. Millar and Rogers (1976) focused their research on the relational nature of communication, developing a coding schema to index relational content, defining message sequences and map transactional patterns. They developed a three digit coding of relational structure which was then amplified to include the control direction of messages.

The classic CRM study, sponsored by NASA (Ruffell-Smith, 1979), provided graphic evidence that the majority of crew performance problems were related to breakdowns in coordination of crew members. It further pointed out that crews having the

highest errors had the most difficulties in crew communication and crew interaction. Task performance was interrupted by demands from other crew members. Foushee and Manos, in their group process study (1981), analyzed voice recordings from the Ruffell-Smith Study - finding some significant communication patterns. They concluded, in part, that there was a tendency for crews which communicated less to perform less well. An even more important role in the group process was played by the type and quality of communication.

METHOD

The objective of this study was to examine the performance and communication of highly trained professional pilots as they flew a LOFT scenario that included equipment failures from one airport to another. Although the flight was made in a simulator, every effort was made to create an impression of line-oriented flight realism for the subject-pilots. This level of realism was necessary to bring about accurate verbal and skill responses from the subjects. Despite of the realism of the task, a high level of experimental control was maintained throughout the experiment.

Experimental Facilities

The experimental facilities consisted of a T-40 twin-jet simulator, an experimenter/ATC station, a PDP 11/34 minicomputer, and a video recorder. The T-40 simulates a T-39 aircraft in the Air Force, which is a small twin jet used to transport generals and other high-ranking officers. Its counterpart, in civilian aviation is the Sabreliner, a common corporate jet. The T-40 cockpit seats a pilot and copilot and has a third seat behind the flight crew for a non-flying crew member or instructor. It has all of the necessary instruments and controls for a realistic instrument flight. It is mounted on a motion platform with two degrees of freedom - pitch and roll.

The experimenter/ATC station is connected to the T-40, providing duplicates of many of the cockpit instruments and a plotter showing the current status of the flight. At this station, the desired navigation world can be programmed. A communications system permits the controller to direct the flight from that point. Numerous system failures can be introduced from this station, which also has initial condition and slewing capabilities.

The PDP 11/34 minicomputer was interfaced with the T-40 to automatically record 13 performance parameters. These include, altitude, heading, course deviation, vertical speed, throttle, gear, flap, speedbrake, and time.

A video camera was mounted on the door of the simulator which

provided a panoramic view of the cockpit and the back of the pilot's heads. Most non-verbal movements could be picked up from this view. Separate microphones were installed to pick up the conversations between the pilots and ATC for the video recorder.

Experimental Subjects

The subjects used in this experiment were corporate pilots and a few airline pilots from Ohio and surrounding states who volunteered to serve. No payment was offered or made for the service. All subjects were experienced jet or turbo prop pilots with at least 50 hours in a turbine aircraft of some type. Efforts were made to accomodate the schedules of the pilots, including flying at all hours and with the crew of their choice. In every case, both members of the crew were subjects in the study. Table 1 presents the experience levels of the experimental subjects used in this study.

Table 1. Experience Levels of Experimental Subjects

Sub #	Position	Age	Cert	Total Hrs	Simul	Recent	Turbine
015	F/O	24	Com	1,350	0	300	150
019	F/O	30	ATP	4,500	0	163	1,050
023	Capt	42	ATP	13,500	70	250	5,000
025	Capt	36	ATP	5,400	30	150	1,000
026	F/O	42	Com	3,500	30	200	200
027	Capt	54	ATP	10,100	150	25	7,000
028	F/O	45	Com	4,300	12	80	250
029	Capt	43	ATP	6,500	20	150	2,000
030	Capt	36	ATP	7,500	30	150	3,300
032	F/O	33	Com	3,150	37	210	1,010
033	Capt	37	ATP	2,000	85	200	2,000
038	F/O	47	ATP	10,700	80	100	700
039	Capt	41	ATP	7,200	5	35	1,000
041	F/O	36	ATP	7,800	350	200	4,500
044	F/O	42	ATP	7,000	50	200	2,800
045	Capt	41	ATP	7,000	150	200	6,000
048	Capt	39	ATP	6,000	300	250	300
049	F/O	25	ATP	3,350	4	300	1,200
050	Capt	42	ATP	12,000	250	200	2,500
051	F/O	30	ATP	3,100	100	200	300
054	F/O	34	ATP	5,500	0	100	400
055	Capt	44	ATP	5,000	100	150	1,500
056	Capt	46	ATP	16,400	110	455	14,300
057	F/O	33	ATP	4,400	12	150	52
064	F/O	31	ATP	3,950	25	250	2,000
065	Capt	32	ATP	4,300	30	250	1,700

Experimental Procedures

Familiarization. Subjects were permitted to appear for their initial familiarization flight either alone or with a qualified fellow crew member. Subjects were given a series of questionnaires to fill out prior to beginning their familiarization flight. These questionnaires (shown in Appendix A) include a biographical questionnaire focusing on flight experience, a consent form, and a Personal Attributes Questionnaire (PAQ).

Following the completion of these questionnaires, subject-pilots were seated in the T-40 simulator for the cockpit familiarization. They were given a T-40 Familiarization sheet (shown in Appendix A) and a audio tape recorder with a cockpit familiarization tape. They were told to listen to the tape and perform all cockpit functions suggested on the tape. The tape led them through all aspects of the cockpit and operation of the simulator. This part of the familiarization took about 20 minutes to complete.

Following the completion of the cockpit familiarization, the experimenter discussed with the subject pilots any questions that they may have had in the operation of the simulator. Then the experimenter took his/her place at the ATC station and directed a familiarization flight around a closed-loop course in the Minneapolis area. This flight included a takeoff from Minneapolis on Runway 29L, a climb out on V13 to Gopher VOR, a turn onto V2 to Press Intersection, a direct to Farmington VOR, and an ILS Runway 4 approach into Minneapolis airport. If there were two pilots in the familiarization, both received a turn at the controls for the flight while the other served as copilot. If only one pilot was present, the experimenter served as the copilot in the familiarization.

Personal Attributes Questionnaire. One of the objectives of this study was to determine the effect of individual communication style, in general, on cockpit communication and performance. At NASA's suggestion, the Personal Attributes Questionnaire (PAQ), an instrument developed by Spence and Helmreich (1978), was chosen as the instrument to identify pilots who were high or low on "Expressivity" and high or low on "Instrumentality". It was expected that most pilots would score high on instrumentality because they tend to be "goal" oriented individuals. It was not known where they would score on the expressivity scale.

The PAQ, shown in Appendix A, is a 62-item questionnaire consisting of two parts. Although our subjects completed all 62 items, they were scored only on Part I, the first 40 questions.

The following formuli were used to compute the instrumentality (I) and expressivity (E) score:

$$I = 3 + 9 + 16 + 26 + 28 + 31 + 33 + 40$$

$$E = 5 + 11 + 13 + 15 + 20 + 25 + 35 + 36$$

Where: The numbers represent question numbers in the instrument.
The numbers used for computation are the subject's responses to the questions.
Responses identified as "A" through "E" are scored "0" through "4", respectively.
Question 26 is scored in the reverse direction.

The following criteria were used to identify pilots on the two scales:

High I/High E - $I \geq 21$, $E \geq 23$

High I/Low E - $I \geq 21$, $E < 23$

Low I/High E - $I < 21$, $E \geq 23$

Low I/Low E - $I < 21$, $E < 23$

Where: I = Instrumentality or goal orientation

E = Expressivity or group orientation

As indicated below, the experiment was designed to systematically match pilot and copilot by their PAQ score so that each combination of high and low expressivity was equally represented in each position. However, because our pilots were volunteering their time, we sometimes had to compromise the experimental design to obtain a particular crew to serve as subjects. Our particular group of pilots happened to have more low expressivity people than high. Consequently, we ended up with more pilots in this group.

Experimental flight. Following the familiarization, an experimental flight was made consisting of a "Line Oriented Flight" from Milwaukee to Minneapolis. Subject pilots were given a previously prepared flight plan for the flight as well as present and forecast weather information, and aircraft weight and fuel status prior to takeoff (Appendix B). They were permitted to prepare for the flight together but they were encouraged to do much of that preparation in the cockpit. When the pilots entered the cockpit, the video recorder was turned on, recording all conversation and activity. During the takeoff roll, the computer

was turned on to record the performance of the crew throughout the flight.

During the experimental flight, the experimenter served as the air traffic controller. No other assistance was given to the crew. Two failures were introduced, an engine failure during the enroute phase of the flight at FL280 and a glideslope failure which did not become evident until the interception of the ILS. Realistic weather conditions were introduced to direct the flight to the destination and prevent wide deviations from the intended course.

Experimental Design

The experimental design for this study is a mixed design with two between subject factors, each having two levels, and one within subject factor with several components. The two between-subject factors, shown in Figure 1, were expressivity and crew position (captain vs first officer). Our plan was to run six crews of each type, provided they could be found. The within subject factor was task and included a number of sub-tasks as candidates for analysis including, departure, enroute before and after engine failure, letdown, and approach. The dependent measures were communication (type and frequency) and flight control performance (measured automatically on the computer).

		CAPTAIN	
		Hi I/Hi E	Hi I/Low E
F/O	Hi I/Hi E	6 crews	6 crews
	Hi I/Low E	6 crews	6 crews

Figure 1. Experimental design

We had planned to do a replication of the above design with crews in a "fatigue" condition (after 11:00 PM). However, because we were unable to find any crews who were willing to make the volunteer flights in this "fatigue" condition, this part of the design had to be dropped. We would suggest that future experiments requiring corporate flight crews in such a condition must provide funding for meals, accomodations, and service compensation for the subjects.

Data Analysis: Communication Coding

One of the most challenging and important aspects of this experiment was the analysis of the communication data recorded on video tape. To determine the effect of the variables of concern, it was necessary to establish a reliable methodology for quantifying communication data. This development effort began with a review of the communication coding literature. The most promising source was an article by Rogers and Farace (1975) in which the authors present a communication coding scheme designed to show the impact of "control" being exercized in dyadic communications. Their objective was to show when each member was demonstrating "one-up-manship" or "one-down-manship".

Our coding scheme for cockpit communication, shown in Table 2, is designed to identify a similar control factor. It employs some of the particular forces that are present in cockpit communication. The first four terms in the control code, "command," "request," "suggestion," and "observation," are designed to indicate the level of cockpit communication control being sought on a continuum similar to that suggested by Tannenbaum and Schmidt (1958). Other terms, such as "disagreement," "question," and "initiate new subject" would show different levels of control being sought in a more general way. Finally, our scheme includes two terms that are fairly specific to the aviation communication environment, "acknowledgment" (usually "Roger") and "checklist call out" which is a part of standard operating procedures. It should also be pointed out that the terms used in the cockpit context are restricted in meaning because of the technology involved. Usage of some of these terms would be quite different in a classic analysis of dyadic communication.

Table 3 presents a concept model of the types of communications expected to result. It indicates what might be expected in terms of control being sought with each type of communication. For example, one would expect that pilots who are high in expressivity would demonstrate a greater rate of communication of the one-up-manship type, and pilots who are low in expressivity would express themselves more frequently with one-down-manship types of communication.

Table 2. Four-Element Coding Scheme Used to Analyze Cockpit Communications.

Coding Scheme	Definitions of Control Terms:
1. Speaker 1. Captain 2. First Officer	Command: An authoritative order directing action of the object. Example: "Gear up."
2. Form 1. Statement 2. Question 3. Exclamation 4. Non-Verbal	Request: A communication asking for something to be given or done, said with less authority than a command. Example: "Would you please call for weather?" Suggestion: To mention or introduce an idea for consideration or action. Example: "Why don't we check the weather at our destination."
3. Direction 1. Other Crew 2. ATC 3. Self or Aircraft	Observation: To offer in communication what one has seen, noticed, or perceived. Example: "We have just passed the station."
4. Control 1. Command 2. Request 3. Suggestion 4. Observation 5. Acknowledgment 6. Checklist Item 7. Answer 8. Disagreement 9. Initiate-Terminate 0. None of Above	Acknowledgment: To indicate receiving and understanding a fact. Example: "Roger, 40RJ." Checklist Item: Communication read from checklist. Example: "Flight instruments - Check." Answer: To respond to a question, suggestion, checklist item, or communication that is not simply an Acknowledgment, or Agreement. Example: "Flight instruments, checked." Disagreement: To differ in opinion. Example: "No, I don't think we should try that approach." Initiate-Terminate: To begin or end a line of thought. Example: "Where did you learn to fly anyway?"

Table 3. Predicted Cockpit Communication Control as a Function of Form and Control Type.

↑ One-up-manship

↓ One-down-manship

→ Across - neither up nor down

— Unlikely communication or not clearly interpretable

	FORM			
	Statement	Question	Exclamation	Non-Verbal
1. Command	↑	↑	↑	↑
2. Request	↑	→	↑	↑
3. Suggestion	→	→	↑	—
4. Observation	→	↓	→	→
5. Acknowledgment	↓	—	—	↓
6. Checklist	→	—	↑	—
7. Answer	↓	↓	↑	↓
8. Disagreement	↑	↑	↑	↑
9. Initiate-Terminate	↑	↑	↑	—
0. Other	—	—	—	—

RESULTS

The results of this investigation cover four major types of data: PAQ results, performance results, communication results and debriefing results. Because the number of crews found in two of the expressivity conditions was so small (two), standard statistical tests were not possible. Therefore, instead of providing these test results, the data are presented showing trends which are useful in determining the need for further research.

PAQ Results

A total of 61 pilots took the PAQ and received the familiarization flight. Of these, 3 were low on Instrumentality, 58 were high. On the Expressivity scale, 24 of these pilots were high and 37 were low. Of the 61 pilots, 26 made up 13 crews that successfully completed their experimental flights. Table 4 presents the PAQ scores for the 26 pilots who made successful experimental flights.

Table 4. PAQ Scores (I/E) of Experimental Pilots.

Expermental Condition	Captain (Sub #) I/E	F/O (Sub #) I/E
Capt Hi E, F/O Hi E	22/23 (039)	22/28 (038)
	27/24 (050)	22/25 (049)
	30/27 (056)	26/24 (057)
Average	26/25	23/26
Capt Hi E, F/O Low E	23/27 (027)	21/22 (028)
	23/23 (065)	24/17 (064)
Average	23/25	23/20
Capt Low E, F/O Hi E	26/17 (030)	19/24 (019)
	23/19 (033)	22/23 (032)
Average	25/18	21/24
Capt Low E, F/O Low E	26/22 (023)	24/21 (015)
	23/21 (025)	18/19 (026)
	21/21 (029)	29/17 (041)
	27/11 (048)	23/22 (051)
	24/22 (055)	21/22 (054)
	28/22 (045)	24/21 (044)
Average	25/20	23/20

One can see from Table 4 above that, among the 13 crews who flew the experimental flights, we did not get an even mixture of each combination of high and low expressivity. In fact, there were three crews in which both captain and first officer were high in expressivity. There were two crews with a high expressivity

captain and low expressivity first officer, two crews with a low expressivity captain and high expressivity first officer, and six crews in which both captain and first officer were low in expressivity.

Performance Results

It should be pointed out first that all crews performed the LOFT exercise very well, including coping with the engine failure, flying to the destination, and making the single-engine, localizer-only approach. All made the flight as requested in a professional manner that appeared to represent the way they would have flown in the airplane. Only one crew refused to participate in the experiment when it came time to sign the consent form. This crew was from the FAA and felt that signing the form was in violation of their employment regulations. Many comments concerning the quality of the simulation and experimental procedures can be found in the answers to the debriefing found in Appendix D.

Although 13 different performance items were recorded during the experimental flight, for a number of technical reasons, the only consistantly reliable result was altitude deviation from 28,000 feet during the enroute portion of the flight. The results of this analysis, shown in Table 5, indicate that pilots, overall, did better at altitude control before the engine failure than following the engine failure. They also show that captains who scored high on expressivity maintained their altitude much better than those who scored low on this measure. This observation is true both before as well as after the engine failure. Captains usually had manual control of the airplane during this portion of the flight.

Table 5. RMS Altitude Error in Feet for Four Combinations of Crews Before and after Engine Failure (EF).

Expressivity (Capt,F/O)	Before EF	After EF	Average
H,H (n=2 crews)	69	145	107
H,L (n=2 crews)	215	246	230
Average (Hi E Capt)	142	195	168
L,H (n=3 crews)	690	636	663
L,L (n=5 crews)	321	476	398
Average (Lo E Capt)	459	536	497
Overall Average	353	422	387

Communication

<u>Overall results</u>. The main PAQ validation question should be answered in the form of overall communication for those high and low in expressivity. Our communication analysis concentrated on the 20-minute time period from 10 minutes before the engine failure to 10 minutes after the failure. As shown in Table 6, the overall communication rate varied from a low of 2.88 communications per minute before the engine failure for captains with low expressivity, to a high of 5.93 after the engine failure for first officers with low expressivity.

These results tend to show that the PAQ does not predict overall cockpit communication rates very well. High E captains have a higher communication rate than Low E captains, but the reverse is the case for first officers. The results do show that co-pilots make more communications than do the captains, in part, because they are the primary communicator with the ATC. As one would expect, there are higher communication rates after than before the engine failure.

Table 6. Overall Communication Results (In Communications/Min)

	Captain		F/O	
	Hi E n = 5	Lo E n = 8	Hi E n = 5	Lo E n = 8
Before EF	3.32	2.88	2.97	3.72
After EF	4.83	3.58	5.23	5.93
Average	4.07	3.23	4.10	4.82

Table 7 presents detailed overall data showing the communication rate for each captain and first officer for the time period before and after the engine failure that was coded. From these data, one can see the effect of the various combinations of crews have high and low expressivity. Crews made up of one high E member and one low E member tended to have higher rates of communication than crews in which both members were the same.

A weakness in the PAQ as a predictor of overall communication rate is pointed out in the result of one particular crew. The crew made up of 48L,51L had the highest rate of communication of all crews. Yet their PAQ E scores were low. In fact, the first officer's E score was 11, the lowest of all subjects tested. However, this particular subject was one of the most talkative persons this researcher has ever met. The PAQ is obviously testing for another dimension in the case of this individual.

Table 7. Communications by Subject Before and After Engine Failure (H = High Expressivity, L = Low Expressivity)

	Before EF			After EF		
Crew Capt,F/O	# of Com Capt,F/O	Time Coded	Com Rate Capt,F/O	# of Com Capt,F/O	Time Coded	Com Rate Capt,F/O
39H,38H	16,24	9.65	1.66,2.49	21,25	8.77	2.39,2.85
50H,49H	27,32	10.00	2.70,3.20	29,41	6.60	4.39,6.21
56H,57H	22,25	10.68	2.06,2.34	46,41	10.00	4.61,4.10
Totals	65,81	30.33		96,107	25.37	
Average for H,H			2.14,2.67			3.78,4.22
27H,28L	52,36	10.00	5.20,3.60	55,74	10.00	5.50,7.40
65H,64L	50,67	10.00	5.00,6.70	68,108	10.00	6.80,10.8
Totals	102,103	20.00		123,182	20.00	
Average for H,L			5.10,5.10			6.15,9.10
30L,19H	16,23	9.00	1.78,2.56	35,42	10.00	3.50,4.20
33L,32H	29,42	9.80	2.96,4.29	49,89	10.13	4.84,8.79
Totals	45,65	18.80		84,131	20.13	
Average for L,H			2.39,3.46			4.17,6.51
23L,15L	29,36	10.00	2.90,3.60	36,43	10.00	3.60,4.30
25L,26L	28,13	10.12	2.77,1.28	37,28	9.75	3.79,2.87
29L,41L	11,19	10.60	1.04,1.79	13,40	7.17	1.81,5.58
48L,51L	38,64	11.70	3.25,5.47	13,38	3.20	4.06,11.8
55L,54L	31,40	8.53	3.63,4.69	31,52	9.88	3.14,5.26
45L,44L	29,24	9.38	3.09,2.56	39,36	10.62	3.67,3.39
Totals	166,196	60.33		169,237	50.62	
Average for L,L			2.75,3.25			3.34,4.68

Form. As defined by the coding model, "form" refers to the gramatical form used, including statement, question, and exclamation, plus non-verbal forms of communication. Tables 8 and 9 show the communication rate vs the form as defined by the coding model, before and after the engine failure respectively. These data indicate that most of the communications take the form of statements, with questions coming in second. Very few exclamations and non-verbals are offered. An almost equal rate of questions is offered by high E and low E crew members.

It is interesting to note that, although our model predicted that high E crew members would show higher exclamation rates, the reverse is true. In fact, high E captains did not offer a single exclamation before and only two after the engine failure. Low E captains, on the other hand, offered them at the rate of .16 coms/min with high E first officers and .12 coms/min with low E first officers before the engine failure. After the engine failure, the exclamation rate was reduced. High and low E First officers offered about the same number of exclamations regardless of the expressivity of the captain.

Table 8. Communication Rate as a Function of Form Before EF

Crew Cpt,F/O	Time Coded	Statement	Question	Exclamation	Non-Verbal
39H,38H	9.65	14,21	2,1	0,1	0,0
50H,49H	10.00	21,28	6,2	0,1	0,1
56H,57H	10.68	18,22	3,3	0,0	1,0
Totals	30.33	53,71	11,6	0,2	1,1
Ave rate - H,H		1.75,2.34	0.37,0.20	0.00,0.06	0.04,0.07
27H,28L	10.00	39,34	1,1	0,0	2,1
65H,64L	10.00	39,56	8,6	0,3	3,2
Totals	20.00	78,90	9,7	0,3	5,3
Ave rate - H,L		3.90,4.50	0.95,0.35	0.00,0.15	0.25,0.15
30L,19H	9.00	10,22	4,10	2,0	0,0
33L,32H	9.80	24,35	2,5	1,1	2,1
Totals	18.80	34,57	6,15	3,1	2,1
Ave rate - L,H		1.81,3.03	0.31,0.32	0.16,0.05	0.10,0.05
23L,15L	10.00	26,31	2,4	0,1	1,0
25L,26L	10.12	17,12	6,1	3,0	2,0
29L,41L	10.60	6,2	2,1	1,0	0,1
48L,51L	11.70	32,50	5,12	1,1	0,1
55L,54L	8.53	23,34	7,5	1,0	0,1
45L,44L	9.38	21,19	7,4	1,1	0,0
Totals	60.33	125,163	29,27	7,3	3,3
Ave rate - L,L		2.07,2.70	0.48,0.45	0.12,0.05	0.05,0.05

Table 9. Communication Rate as a Function of Form After EF

Crew Cpt,F/O	Time Coded	Statement	Question	Exclamation	Non-Verbal
39H,38H	8.77	20,24	1,1	0,0	0,0
50H,49H	6.60	22,39	7,1	0,1	0,0
56H,57H	10.00	45,40	1,1	0,0	0,0
Totals	30.33	87,103	9,3	0,1	0,0
Ave rate	- H,H	2.87,3.40	0.30,0.10	0.00,0.01	0.00,0.00
27H,28L	10.00	52,64	2,6	0,0	1,4
65H,64L	10.00	54,99	10,6	1,2	3,1
Totals	20.00	106,163	12,12	1,2	4,5
Ave rate	- H,L	5.30,8.15	0.60,0.60	0.05,0.10	0.20,0.25
30L,19H	10.00	25,36	9,6	1,2	0,0
33L,32H	10.13	48,78	0,10	0,0	1,1
Totals	20.13	73,114	9,16	1,2	1,1
Ave rate	- L,H	3.63,5.66	0.45,0.79	0.05,0.10	0.05,0.05
23L,15L	10.00	26,41	9,2	1,0	0,0
25L,26L	9.75	30,25	4,2	0,1	3,0
29L,41L	7.17	11,33	0,7	0,0	0,0
48L,51L	3.20	9,32	3,6	0,0	1,0
55L,54L	9.88	23,47	8,5	0,0	0,0
45L,44L	10.62	28,29	10,7	0,0	1,0
Totals	50.62	127,207	34,29	1,1	5,0
Ave rate	- L,L	2.51,4.09	0.67,0.57	0.02,0.02	0.10.0.00

Direction. Tables 10 and 11 show the communication rate versus the direction before and after the engine failure, respectively. It can be seen that most of the communication is directed at the other crew member. The first officer is the primary communicator with the ATC. However, it is interesting to note that our low E Captains communicated with ATC at a very high rate after the engine failure perhaps not trusting the first officer. First officers tend to talk to themselves more than do the captains.

Table 10. Communication Rate as a Function of Direction Before EF

Crew Cpt,F/O	Time Coded	Other Crew	ATC	Self or Aircraft
39H,38H	9,65	16,16	0,6	0,1
50H,49H	10.00	26,25	1,5	0,1
56H,57H	10.68	21,19	0,6	1,0
Totals	30.33	63,60	1,17	1,2
Ave rate - H,H		2.08,1.98	0.03,0.56	0.03,0.07
27H,28L	10.00	45,30	0,3	7,3
65H,64L	10.00	48,60	0,3	2,4
Totals	20.00	93,90	0,6	9,7
Ave rate - H,L		4.65,4.50	0.00,0.30	0.45,0.35
30L,19H	9.00	14,18	0,5	1,0
33L,32H	9.80	24,31	1,5	2,4
Totals	20.13	38,49	1,10	3,4
Ave rate - L,H		1.89,2.43	0.05,0.50	0.15,0.20
23L,15L	10.00	25,31	0,2	0,1
25L,26L	10.12	20,10	2,0	5,3
29L,41L	10.60	9,11	0,5	0,3
48L,51L	11.70	33,41	1,13	1,6
55L,54L	8.53	26,29	0,9	3,2
45L,44L	9.38	25,19	0,4	1,1
Totals	60.33	138,141	3,33	10,16
Ave rate - L,L		2.72,2.79	0.06,0.65	0.20,0.32

Table 11. Communication Rate as a Function of Direction After EF

Crew Cpt,F/O	Time Coded	Other Crew	ATC	Self or Aircraft
39H,38H	8.77	21,22	0,3	0,0
50H,49H	6.60	26,34	2,6	0,1
56H,57H	10.00	46,29	0,11	0,0
Totals	30.33	93,85	2,20	0,1
Ave rate - H,H		3.07,2.80	0.07,0.66	0.00,0.03
27H,28L	10.00	51,47	1,19	3,8
65H,64L	10.00	68,86	0,10	0,12
Totals	20.00	119,133	1,29	3,20
Ave rate - H,L		5.95,6.65	0.05,1.45	0.15,1.00
30L,19H	10.00	33,34	1,6	0,2
33L,32H	10.13	40,57	6,9	2,23
Totals	20.13	73,91	7,15	2,25
Ave rate - L,H		3.63,4.52	0.35,0.75	0.10,1.24
23L,15L	10.00	34,34	0,9	1,0
25L,26L	9.75	31,14	2,5	1,9
29L,41L	7.17	11,27	0,10	0,3
48L,51L	3.20	10,24	3,3	0,10
55L,54L	9.88	31,35	0,14	0,3
45L,44L	10.62	39,20	0,11	0,5
Totals	50.62	156,154	5,52	2,30
Ave rate - L,L		3.08,3.04	0.10,1.03	0.04,0.59

Control. Figures 1 through 9 present data concerning the four levels communication control from the coding model. Figure 1 shows the overall communication rate for the four control terms that were predicted to indicate decreasing levels of control. As one might expect, a strong interaction is evident along this dimension between the captain and the first officer. Captains make more commands than requests and suggestions. First officers make fewer commands but more requests and suggestions. Both pilots make a lot of observations but the co-pilots make many more. The interaction is evident both before and after the engine failure, although captains make many more commands after the engine failure than before, as shown in Figures 2 and 3.

Figures 4 through 9 focus on data observed after the engine failure, when the crew is coping with the problem and developing an alternative plan. Figures 4 and 5 examine the two levels of expressivity in captains and first officers, respectively. Figure 4 shows that High E captains make many more suggestions and observations than low E captains, while Figure 5 shows that low E first officers make more requests than do high E first officers. The other control factors result in nearly equal rates of communication for the two levels of expressivity. An interesting observation in these data is that Low E captains and first officers tend to give more requests than suggestions. High E captains and first officers behave in the opposite way. Perhaps, the request represents a lower level of command to low E pilots but a higher level of command to high E pilots.

Figures 6 through 9 focus on the communication behavior of the four types of crews as they are matched on the expressivity scale. In all cases the interaction between the captain and first officer remains intact. However, captains, in the presence of a first officer with the same expressivity level, tend to give a greater number of commands. In expressivity "mixed" crews, first officers make many more observations.

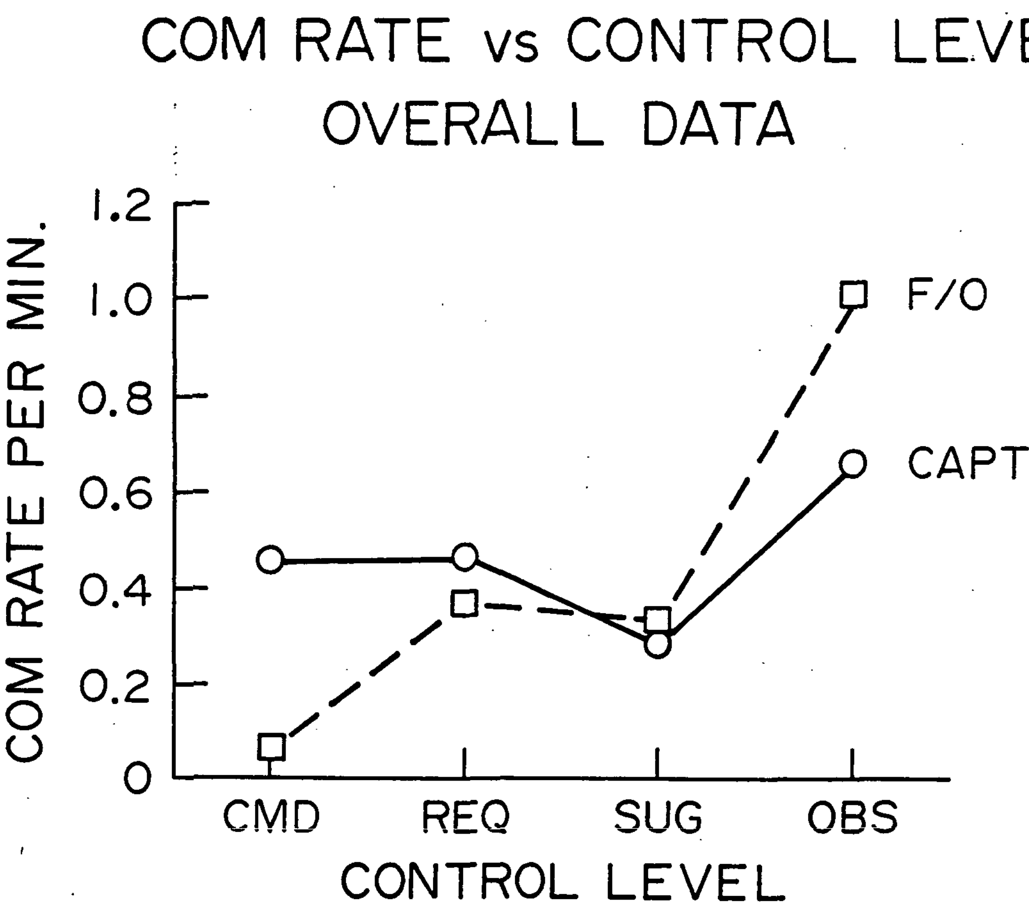

Figure 1. Communication Rate versus Control Level for captains and first officers.

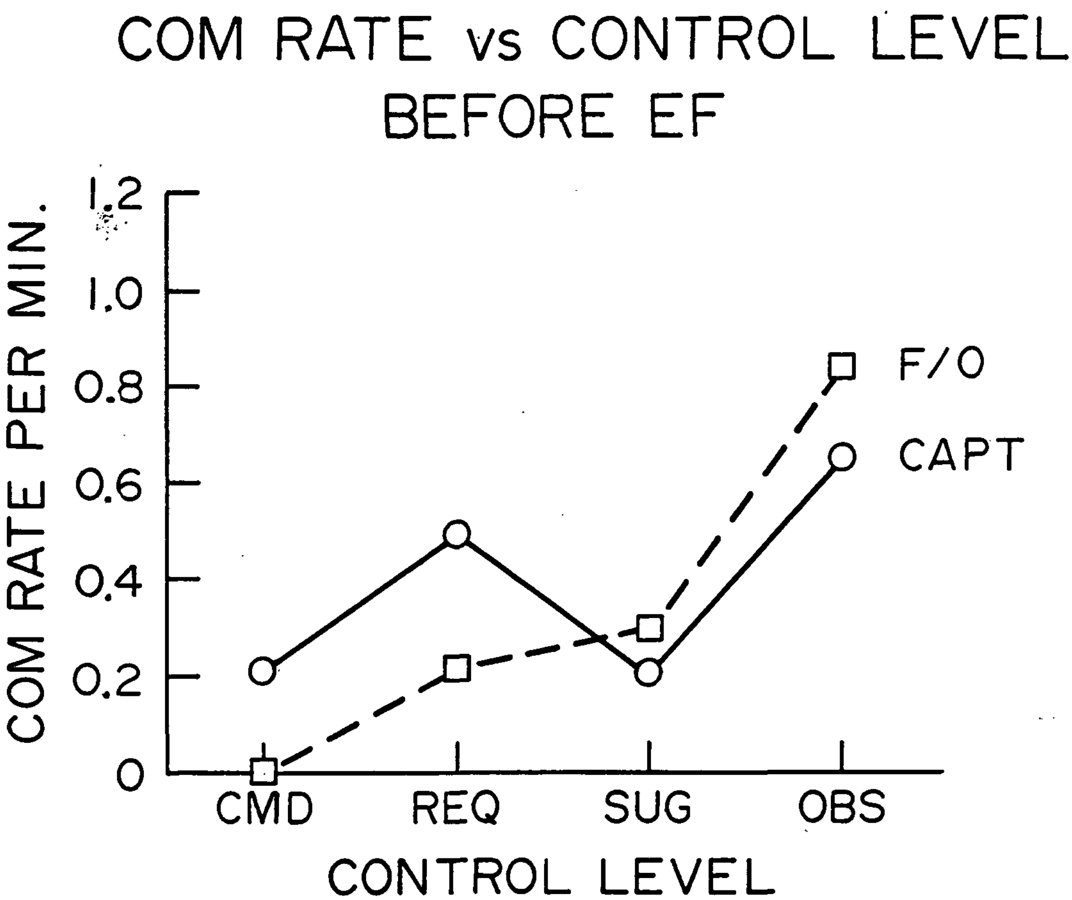

Figure 2. Communication Rate versus Control Level for captains and first officers before the engine failure.

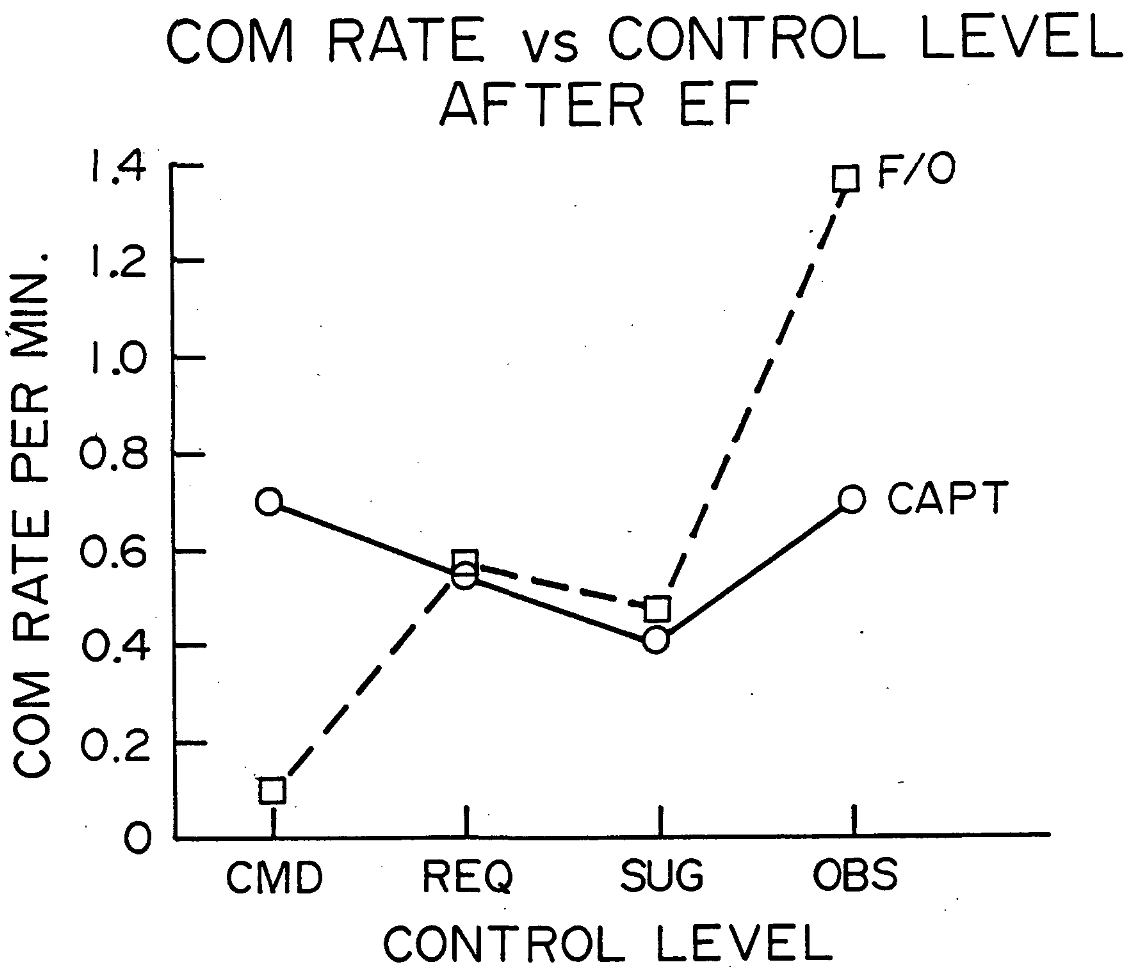

Figure 3. Communication Rate versus Control Level for captains and first officers after the engine failure.

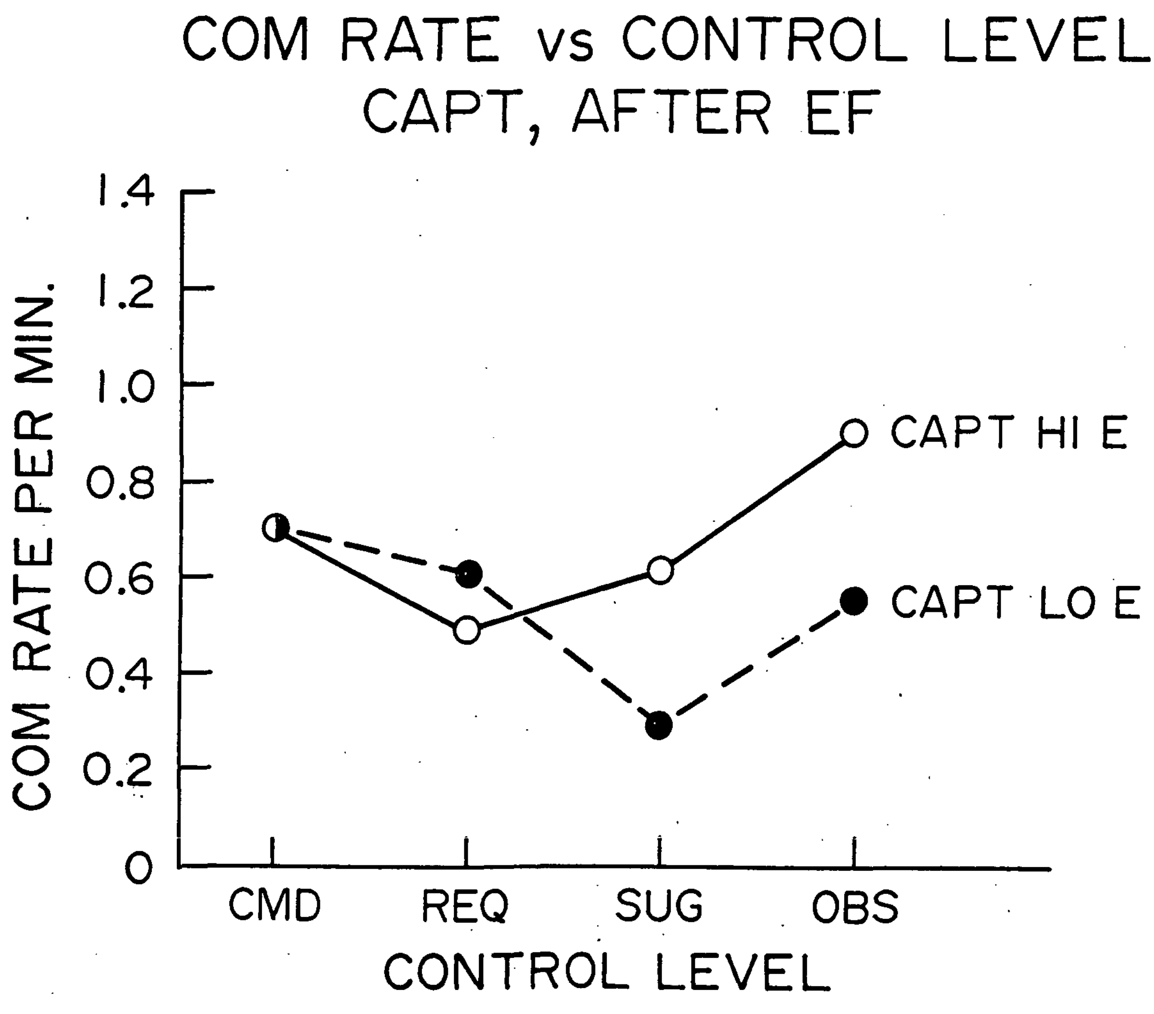

Figure 4. Communication Rate versus Control Level after the engine failure for high and low E captains.

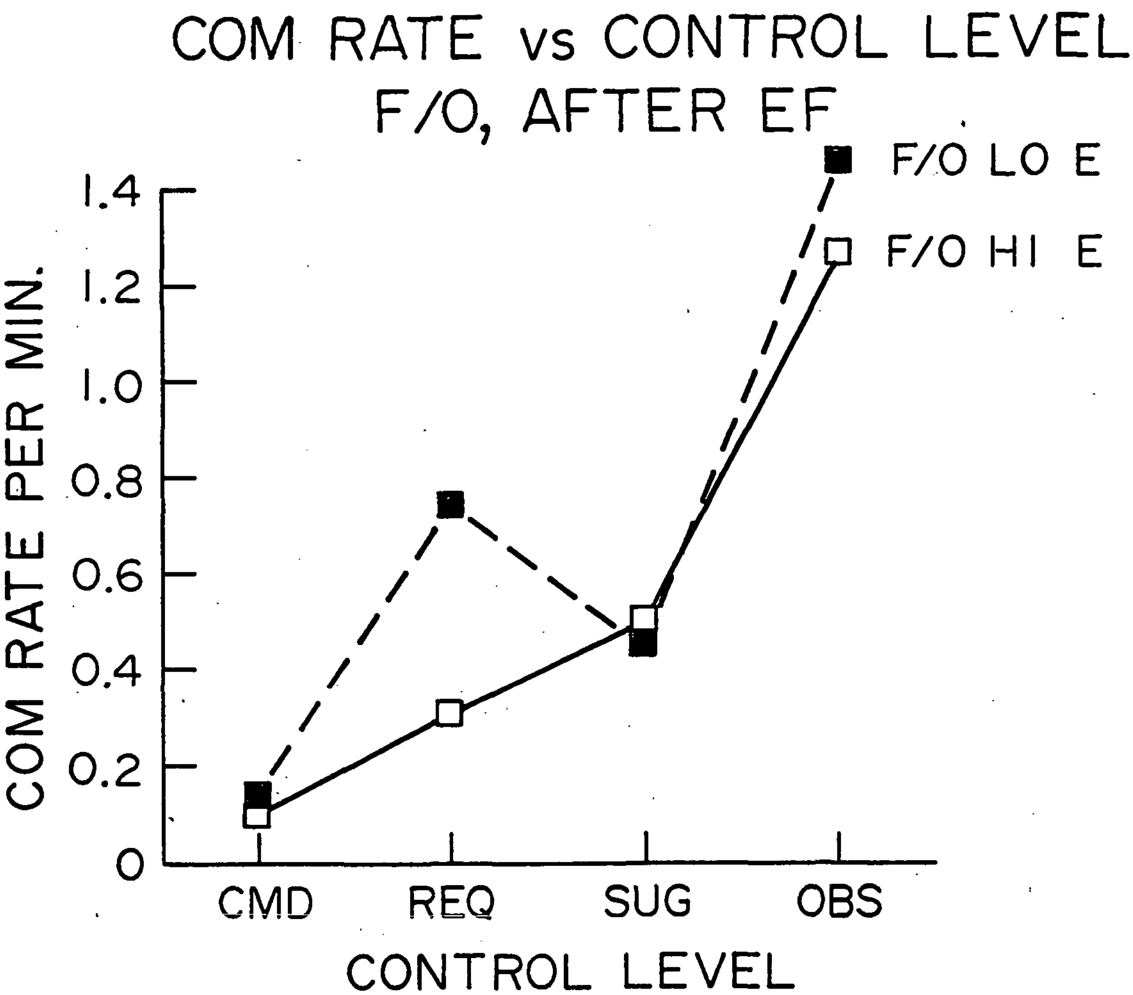

Figure 5. Communication Rate versus Control Level after the engine failure for high and low E first officers.

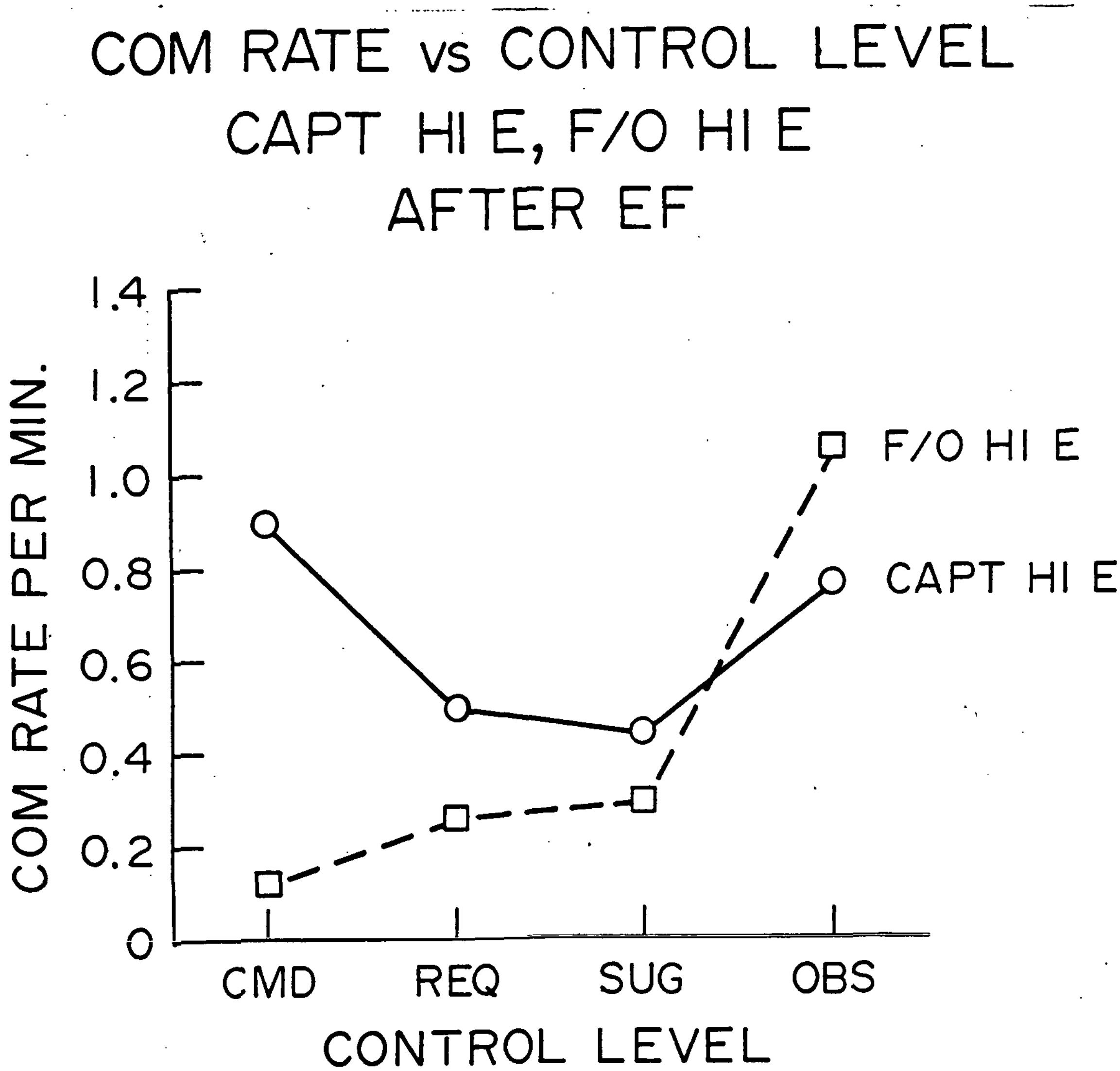

Figure 6. Communication Rate versus Control Level after the engine failure for a "mixed" crew consisting of a high E captain and a high E first officer.

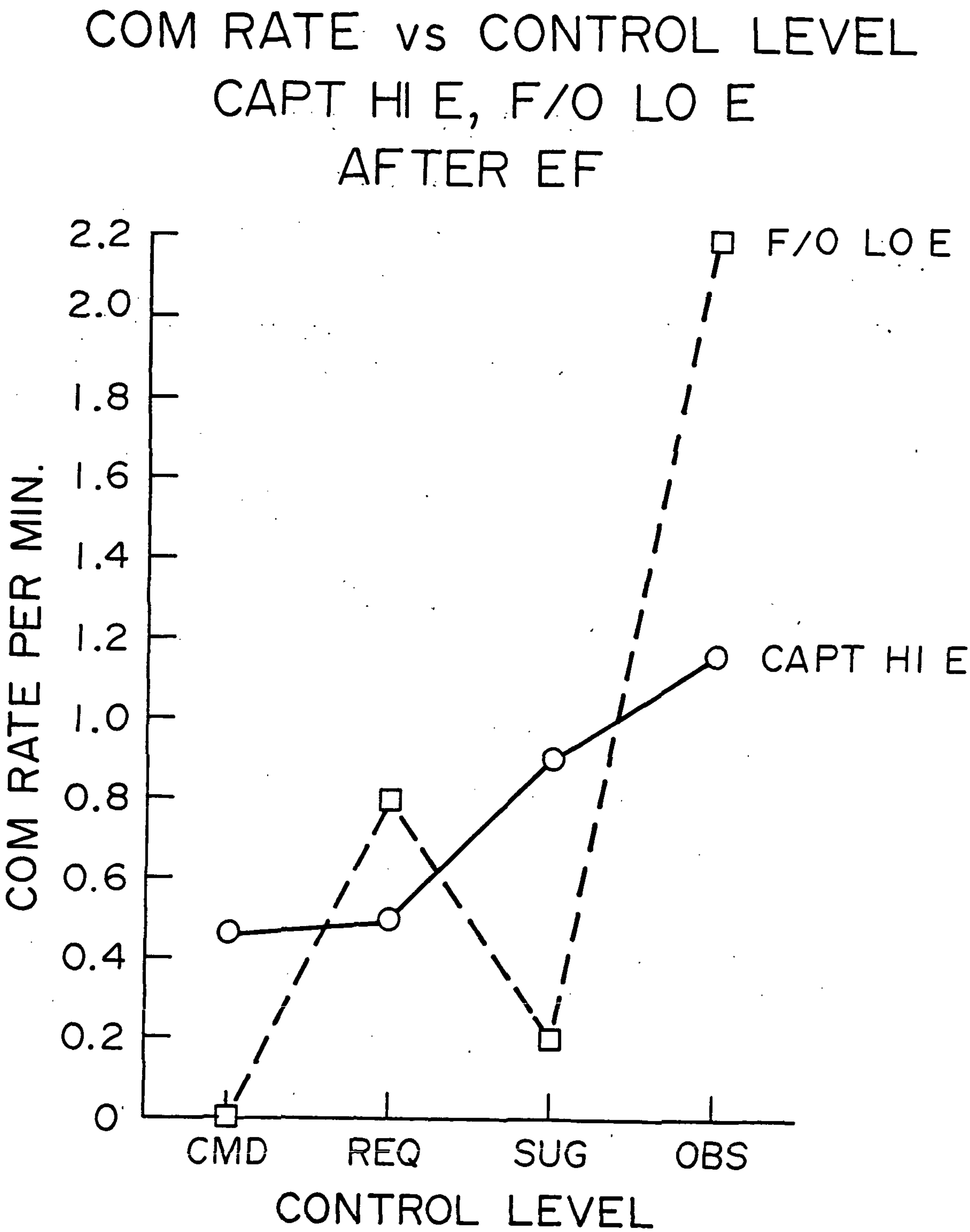

Figure 7. Communication Rate versus Control Level after the engine failure for a crew consisting of a high E captain and low E first officer.

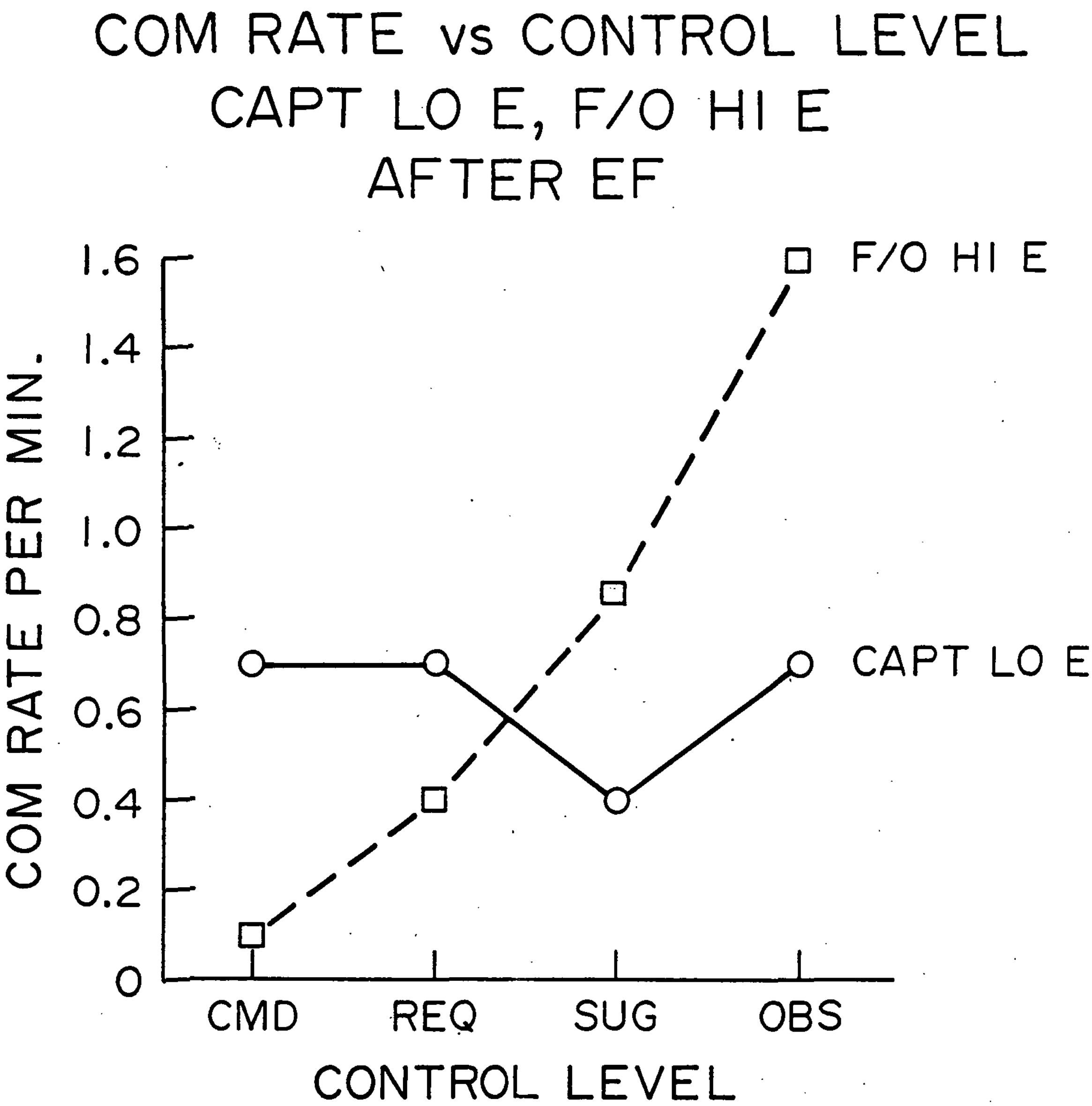

Figure 8. Communication Rate versus Control Level after the engine failure for a crew consisting of a low E captain and a high E first officer.

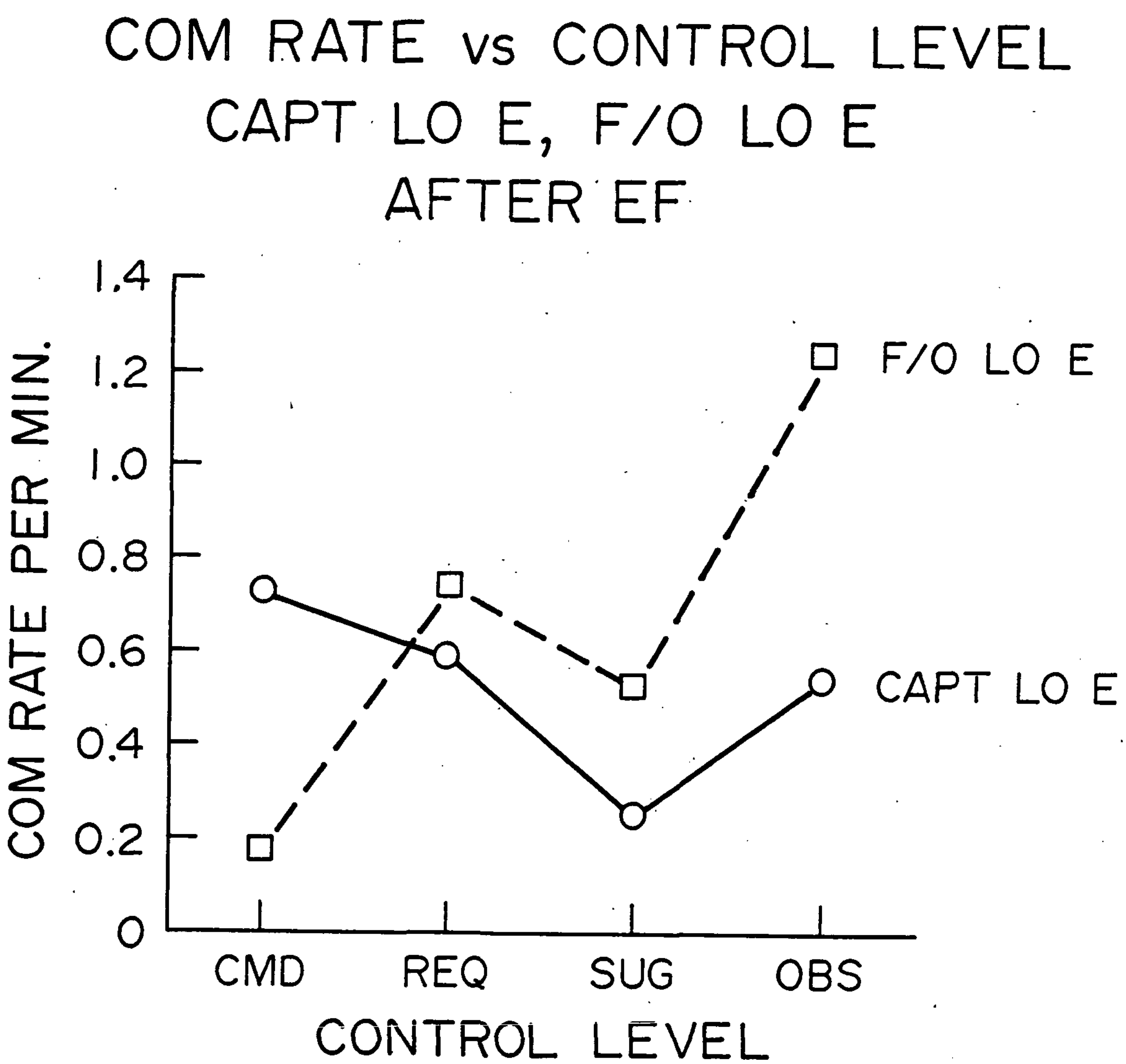

Figure 9. Communication Rate versus Control Level after the engine failure for a crew consisting of a low E captain and a low E first officer.

Other Control factors. Tables 12 and 13 present control data on the other factors of the coding model, including acknowledgments, checklist items, answers, disagreements, and initiate-terminate before and after the engine failure, respectively. High E captains had a higher rate of acknowledgments than low E captains both before and after the engine failure. First officers did not show this difference. Checklist items are almost exclusively offered by first officers except for one of our low E captains (the same one who talked frequently to ATC).

Disagreements and initiate-terminate appear to be reliable control factors predicted by the PAQ. High E captains and first officer raise more of both of these type of communications than do low E crew members. This observation is true both before and after the engine failure.

Table 12. Control Communications Before Engine Failure

Crew Cpt	Crew F/O	Time Coded	Acknowl C, FO	Checklt C, FO	Answer C, FO	Disagre C, FO	Ini-Ter C, FO
39/H	38/H	9.65	1,3	0,0	0,2	0,2	0,3
50/H	49/H	10.00	3,5	0,0	3,7	2,2	2,3
56/H	57/H	10.68	2,4	0,0	5,4	0,0	2,5
Total		30.33	6,12	0,0	8,13	2,4	4,11
Ave rate - H,H			0.20,0.40	0.00,0.00	0.26,0.43	0.07,0.13	0.13,0.36
27/H	28/L	10.00	8,3	0,4	2,15	0,0	1,1
65/H	64/L	10.00	8,3	0,10	15,13	1,0	0,1
Total		20.00	16,6	0,14	17,28	1,0	1,2
Ave rate - H,L			0.80,0.30	0.00,0.70	0.85,1.40	0.05,0.00	0.05,0.10
30/L	19/H	9.00	1,2	0,4	0,1	1,0	0,1
33/L	32/H	9.80	2,2	8,6	3,2	0,1	1,10
Total		18.80	3,4	8,10	3,3	1,1	1,11
Ave rate - L,H			0.16,0.21	0.43,0.53	0.16,0.16	0.05,0.05	0.05,0.59
23/L	15/L	10.00	0,7	0,0	1,4	0,0	0,0
25/L	26/L	10.12	1,0	0,0	1,5	2,0	6,0
29/L	41/L	10.60	0,0	0,1	3,5	0,0	1,4
48/L	51/L	11.70	3,7	0,0	7,11	0,0	2,5
55/L	54/L	8.53	2,2	0,5	8,14	0,0	4,6
45/L	44/L	9.38	2,2	0,0	3,5	0,0	7,3
Total		60.33	8,18	0,6	23,44	2,0	20,18
Ave rate - L,L			0.13,0.30	0.00,0.10	0.38,0.73	0.03,0.00	0.33,0.30

Table 13. Control Communications After Engine Failure

Crew Cpt	F/O	Time Coded	Acknowl C,FO	Checklt C,FO	Answer C,FO	Disagre C,FO	Ini-Ter C,FO
39/H	38/H	8.77	3,5	0,2	2,1	2,1	0,1
50/H	49/H	6.60	6,3	0,13	2,11	1,1	4,3
56/H	57/H	10.00	7,15	0,2	0,0	0,0	0,3
Total		25.37	16,23	0,17	4,12	3,2	4,7
Ave rate -		H,H	0.63,0.91	0.00,0.67	0.16,0.47	0.12,0.08	0.16,0.28
27/H	28/L	10.00	8,10	0,13	10,9	0,0	3,3
65/H	64/L	10.00	9,7	0,14	5,2	1,0	0,1
Total		20.00	17,17	0,27	15,11	1,0	3,4
Ave rate -		H,L	0.85,0.85	0.00,1.35	0.75,0.55	0.05,0.00	0.15,0.20
30/L	19/H	10.00	1,2	0,7	1,2	0,0	0,0
33/L	32/H	10.13	10,10	0,16	15,7	1,3	3,6
Total		20.13	11,12	0,23	16,9	1,3	3,6
Ave rate -		L,H	0.55,0.60	0.00,1.14	0.79,0.45	0.05,0.15	0.15,0.30
23/L	15/L	10.00	5,7	0,6	4,8	1,1	2,0
25/L	26/L	9.75	4,5	0,5	4,1	0,1	3,3
29/L	41/L	7.17	3,4	0,12	5,0	0,0	0,3
48/L	51/L	3.20	0,1	0,12	3,2	0,0	2,3
55/L	54/L	9.88	1,1	0,7	5,17	0,0	0,4
45/L	44/L	10.62	3,7	0,7	5,2	0,0	2,1
Total		50.62	16,25	0,49	26,30	1,2	9,14
Ave rate -		L,L	0.32,0.49	0.00,0.97	0.51,0.59	0.02,0.04	0.18,0.28

Debriefing Results

Table 14 presents the results of a debriefing questionnaire in which pilots were asked for opinions concerning their attitudes about cockpit communication. This questionnaire consists of the 11 most significant questions from a 25-item instrument used extensively by Dr. Robert Helmreich in his research on airline crews. In this questionnaire, pilots were to respond by circling the response of their choice from the following:

1) Disagree Strongly, 2) Disagree Slightly, 3) Neutral, 4) Agree Slightly, or 5) Agree Strongly

The 11 questions were as follows:

1. The pilot flying the aircraft should verbalize his plans for maneuvers and should be sure that the information is understood and acknowledged by the other pilot.

2. It is important to avoid negative comments about the procedures and techniques of the other crew members.

3. Overall, successful flightdeck management is primarily a function of the flying proficiency of the captain.

4. The captain should take control and fly the aircraft in an emergency and non-standard situations.

5. First officers should not question the decisions or actions of the captain except when they threaten the safety of the flight.

6. Captains should encourage their first officers to question procedures during normal flight operations and in emergencies.

7. There are no circumstances (except total incapacitation) where the first officer should assume command of the aircraft.

8. Casual conversation in the cockpit during periods of low workload can improve crew performance.

9. My decision making ability is as good in emergencies as in routine flying situations.

10. An effective pilot can leave behind personal problems when flying.

11. Pilots should feel obligated to mention their own psychological stress or physical problems to other flightcrew personnel before or during a flight.

Table 14. Results of Helmreich Attitude Questionnaire

Crew Cpt,F/O	Question 1	2	3	4	5	6	7	8	9	10	11
39/H,38/H	4,5	5,4	2,2	3,4	1,5	2,5	1,1	5,4	2,5	2,4	4,4
50/H,49/H	5,5	2,5	2,1	3,1	1,2	5,4	1,4	5,5	5,5	2,4	4,5
56/H,57/H	5,5	5,1	2,2	2,2	1,2	5,4	2,3	4,4	4,4	4,5	5,5
27/H,28/L	5,5	5,1	4,5	1,1	1,1	5,5	1,1	4,4	4,1	1,4	5,5
65/H,64/L	5,5	1,4	5,2	3,4	5,1	1,5	1,2	5,5	5,4	3,4	4,4
30/L,19/H											
33/L,32/H	5,5	3,1	4,1	5,1	4,1	3,5	3,1	5,4	3,4	4,2	3,4
23/L,15/L											
25/L,26/L	5,5	1,2	3,4	5,4	4,4	5,5	1,3	3,5	3,4	1,5	5,5
29/L,41/L	4,4	3,2	4,4	4,2	2,1	4,5	4,1	4,4	4,5	4,4	3,3
48/L,51/L	1,5	-,5	1,2	1,3	4,2	5,5	1,4	4,5	1,4	3,3	1,3
55/L,54/L	5,5	5,3	2,1	4,1	1,1	5,5	2,1	4,3	3,4	5,5	5,4
45/L,44/L	5,5	4,4	1,1	3,3	4,4	4,4	4,5	4,4	2,4	4,4	1,4

Table 15 is a summary of Attitude Survey. It can be seen from this table that the strongest overall negative response was to Question 7, which refers to the circumstances where the first officer should assume responsibility. All pilots, but captains in particular, believe that there are circumstances (other than total incapacitation) where the first officer should assume command. The most agreement was found with the first question which states that the pilot flying should verbalize his plans and be sure they are understood. These results are similar to those found by Helmreich for airline crews (Helmreich, 1983; Helmreich, Foushee, Benson, and Russini, 1985).

Question	Captain H	Captain L	First Officer H	First Officer L	Ave
1	4.80(0.40)	4.17(1.46)	5.00(0.00)	4.86(0.35)	4.71
2	3.60(1.74)	3.20(1.33)	2.75(1.79)	3.00(1.31)	3.14
3	3.00(1.26)	2.50(1.26)	1.50(0.50)	2.71(1.48)	2.42
4	2.40(0.80)	3.67(1.37)	2.00(1.22)	2.57(1.18)	2.66
5	1.80(1.60)	3.17(1.21)	2.50(1.50)	2.00(1.31)	2.36
6	3.60(1.74)	4.33(0.75)	4.50(0.50)	4.86(0.35)	4.32
7	1.20(0.40)	2.50(1.26)	2.25(1.30)	2.43(1.50)	2.09
8	4.60(0.49)	4.00(0.58)	4.25(0.43)	4.29(0.70)	4.28
9	4.00(1.09)	2.67(0.94)	4.50(0.50)	3.71(1.16)	3.72
10	2.40(1.02)	3.50(1.26)	3.75(1.09)	4.14(0.64)	3.45
11	4.40(0.49)	3.00(1.63)	4.50(0.50)	4.00(0.76)	3.98

CONCLUSIONS AND DISCUSSION

The results of this study indicate that through the use of basic group communication coding techniques modified for the cockpit setting, cockpit communication can be assessed in a reliable, useful, and consistant way. However, our method is extremely tedious. We used independent study students as coders which meant that training for standardization was an important task. The coders not only put all communication into the designated categories, but they also transcribed the phrases that they coded so they could be easily checked. Thus, it was possible to code only about 20 minutes of each flight. A real-time coding technique, such as KLM uses in their training course, may be of value.

The PAQ yields, at best, mixed results in terms of its prediction of overall communication rate. However, it does predict certain types of communication such as disagreement, commanding, and initiate-terminate. Other instruments are need to predict communication behavior.

The crews with the highest levels of communication were those with a mix of high and low expressivity in the crew. However, we had only two crews in each of these conditions so the conclusion is tentative, at best. The crews with the lowest level of communication rate were the low, low crews.

All pilots performed the task well. However, the crews headed by high expressivity captains maintained altitude much better than those with low expressivity captains. Perhaps the PAQ measures confidence in skill level more than expressivity.

Control levels of communication (Command, Request, Suggestion, Observation) result in a strong interaction between captains and first officers both before and after the engine failure. Low E captains and first officers tend to give more requests than suggestions. High E captains and first officers behave in the opposite way. Perhaps the request is a lower level of command to low E pilots but a higher level of command to high E pilots.

First officers exhibit a higher level of communication overall than do captains, not entirely explained by the almost exclusive conversation with ATC. This was not the case in the KLM flight shown in Appendix F.

Almost all pilots are high on instrumentality or goal orientation. In our study, we found more pilots who were low than high on expressivity. Because we used volunteers, perhaps, we had a greater number of pilots who were willing to participate, in part, because, as people low in expressivity, they were less willing to say no than the high expressivity pilots. Another

factor that may have influenced the results was the fact that a number of our pilot-subject were either unemployed or changed employment between the familiarization and experimental flight.

In the debriefing attitude survey, our pilot subjects generally agreed with the results of the Helmreich Attitude survey of airline pilots. They believe that captains have the responsibility to provide verbal communication concerning all of their intentions as far as the aircraft is concerned. They also believe that there are circumstances other than total captain incapacitation which require first officer take over of command of the aircraft.

More research is needed to establish the validity of expressivity measurement techniques and cockpit communication analysis techniques. We believe that other generalized instruments as well as cockpit specific instruments should be used in the assessment of cockpit expressivity. The KLM technique may hold some promise along these lines.

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APPENDIX A: Cockpit Familiarization Script

Updated March 7, 1984
R. Jensen
J. Eggspuehler

T-40 COCKPIT FAMILIARIZATION

This tape is designed to acquaint you with the T-40 flight simulator. If you wish to stop the tape for any reason like locating a knob or switch, simply depress the pause button on the recorder. You may want to locate this button now for reference.

You should have the T-40 checklist available for reference as you listen to this tape. Also, as the tape takes you through the cockpit, feel free to flip switches, turn knobs, or move controls to check their responses. This will help you remember the idiosyncracies of our cockpit.

You should be seated in the cockpit. If you need to adjust your seat, the knobs are located on the wall side. The front knob moves the seat horizontally and the back knob, vertically. You should have the T-40 checklists handy for reference as you listen to this tape.

The T-40 is a simulator for the Air Force T-39 and the Sabreliner aircraft. This simulator came from the Air Force and it has several military items; the most noticeable of which are a TACAN Radio and an "identify friend or foe" transponder; however, you will not need any military training for our simulation.

Let us go through the cockpit step by step. This briefing will divide the front panel into three segments (left side, center, and then right

side). Last, we will cover the center console and control yoke. For each section, the briefing will start at the top of the panel and work down. Again, stop this recording if you would like to examine something or if you have questions.

Starting our orientation on the pilot's side, at the top you will see the marker beacon lights, as well as a hi-lo switch and volume control for the ILS marker beacon. To the right is the clock with working stop watch. The second hand and additional minute hand are for the stop watch. Try this now by depressing the button on the upper right to be sure you know how it works. Press the button two more times to reset the stopwatch. Beneath that are the basic flight instruments. There is also a Mach Meter which will be used as a performance instrument. Notice the accelerometer dial and gyro compass slaving switch; both of these are non-functional in this simulator.

Look at the Course Select and HSI bearing toggle switches. The Course Select switch allows you to select either TACAN or VOR/ILS for course deviation indications on the HSI. The Course Select switch does not affect the command bars on the attitude indicator. Either ADF or TACAN information is presented on the small pointer located on the outside of the HSI compass rose. When the switch is placed in NORMAL position, this pointer will give you bearing information to the TACAN. In the ADF position the needle acts as an ADF giving you bearing information to the ADF station selected. Because these important switches have somewhat unusual functions, be sure that you understand their proper function.

The Flight Director is controlled by two switches (the flight director mode switch and the heading mode switch). When you put the heading mode in "manual", the command bar will steer you to the heading that you have selected on your HSI heading bug. In the "Normal" position the command bar will be deactivated unless the Flight Director Mode is in the ILS or ILS Approach position. Notice that the heading set knob is at the bottom left of the HSI. The Heading Mode toggle switch should be in "Normal" to receive signals for the approach.

The three positions on the flight director mode switch are NAV, ILS, and ILS Approach. The NAV position should be used for enroute TACAN navigation. In this position left-right course deviation will be presented on the HSI needle. The ILS mode of the flight director will give you the VOR/ILS receiver and steer you on the localizer course (presented on the HSI needle) using the command bar on the Attitude Indicator. The ILS "Approach Mode" will steer you both to the localizer and to glide-slope using the command bars on the attitude indicator. The glideslope indicator is on the left side of the attitude indicator.

The command bars are conventional for most military flight directors. Their function is to provide commanded pitch (for glideslope) and bank (for localizer) to make course corrections on the ILS more precise. To use them you should steer, using pitch and bank, toward the needle and try to keep the two needles centered. They are very sensitive. Do not attempt to use them until you are well established on the localizer and glideslope. Otherwise, they could lead you astray.

Needle and ball information is presented at the bottom of the attitude indicator.

The last items on the bottom of the left side, are 2 toggle switches - for pitot heat and surface deice. This completes our tour of the left side.

Next look at the center panel. At the very top are two nose-wheel-steering-connect annunciator lights and two non-functional fire pull handles. Beneath these on the left side, is a set of three position toggle switches for audio control. Up is for speaker, center for off and down for headset. All useable nav aids have aural identifiers.

Looking at your engine instruments next, you will see that there are two sets, one for each engine. From top to bottom, these are; first - exhaust-total-pressure (Pt5); second - percent-rpm; third - exhaust temperature; fourth - fuel flow; fifth - oil pressure and, at the bottom, fuel quantity. Percent RPM will be your primary instrument for power information.

Start back up at the top for the radio package. For all the radios, please note the on and off switches because they will <u>not</u> work unless turned on. The TACAN, at the very top is needed for enroute navigation where will you want DME information. Beneath the TACAN is a conventional VHF Com Radio. Beneath the VHF Com radio is a standard VHF Nav radio. To the right of the Nav radio is the ADF receiver. As the ADF is the older "coffee-grinder" type tuner, take a moment to refresh yourself on how to

tune it.

The aircraft checklist has been expanded somewhat to help that you tune your navaids properly for enroute and ILS navigation. Take a look at the BEFORE TAKEOFF and DESCENT checklists now to see how these are set. Three important items in this regard are:

1. Use the TACAN for enroute navigation. Follow the checklist to set it up.
2. For ILS approaches be sure that the COURSE SELECT switch is in the VOR/ILS position.
3. Be sure to use the ADF tuned to the outer compass locator NDB as a backup for the Marker Beacon.

Beneath the radio package are your primary and auxiliary hydraulic pump toggle-switches and gauges. Beneath the engine instruments is the gear handle. Notice that the three-in-the-green lights are underneath the hydraulic gauges. Farther to the right you will see the flap indicator and numerous toggle switches for electrical master, radio instrument master, inverter, left and right DC generator and battery. The last items on the center panel are located back up at the top. These are the three trim gauges and outside air temperature gauge. Beneath them is a press-to-test button for the annunciator panel.

The instruments on the right side are standard. The DME readout is located on the top left. DME is available <u>only from TACAN</u> and both left and right side will read distance from the same TACAN station. There is

also a stop watch on this side and basic flight instruments. There is not a Mach indicator on the right side. The two-needle RMI is clearly marked to indicate that the number 1 needle can be ADF or TACAN as set by the toggle switch on the right side. The Number 2 RMI needle is always set to present information from the VHF Nav radio. The VOR head is selected with the <u>course-select</u> toggle switch. If both pilot and copilot have their course select switch in the same position, the copilot will have a course select inop light <u>on</u> which means that the VOR head is slaved to the pilot's selector. In other words, whatever the Captain dials in for course will be indicated on the Co-pilot's VOR head.

The throttle quadrant is the last area to cover. Starting at the top, you will see two ENGINE MASTER switches as well as a PUSH-TO-START switch. The throttles should be locked in cut-off. To raise the throttles out of this position, press the throttle lock button at the side of the lever while raising the lever. Try this now for each throttle, one at a time.

Engine start is accomplished by depressing the start button and using one hand to hold down the throttle lock button and the other to raise the throttle after the RPM has reached 8%. You may try this now, but be sure to use the checklist.

An important item which is easy to miss is the throttle friction lock located on the left side of the quadrant. Adjust this now to your liking. Last, return the throttles to the their locked cut-off position to shut down the engines.

The speed brake is located on the side of the left throttle lever. It has three positions. The forward is the OFF position. Be sure it is in this position for takeoff. The center or neutral position will keep the speed brakes in whatever position you have selected. It will not bring them in. The back position, which is spring loaded, will deploy the speed brakes. You must hold it back for several seconds against the spring pressure to deploy speed brakes. A word of caution: the only indications of the position of the speed brakes are the position of the switch, a sound of rushing air when they are fully deployed, and the changes to aircraft performance. Each of these indications is quite subtle. The most reliable information is in the position of the speed brake switch.

Back on top of the center pedastel on the right side is the fuel selector switch. In the normal position the left wing tank feeds the left engine, the right wing tank - the right engine and a center fuselage tank feeds both wing tanks. Each fuel quantity guage indicates the quantity of fuel in the respective tank plus half of the quantity from the center fuselage tank.

On the left side of the center pedastel is the engine AIR START switch. It is spring loaded and used to air-start both engines.

Beneath the throttles, to the left is a toggle switch for rudder trim and to the right, a flap switch. Below these are toggle switches for interior and exterior lighting. Of interest to you will be the panel light switch which is a rheostat type and two toggle switches for Nav and anti-collision.

The next line of items has a toggle switch for parking brakes which should be in the "on" position and an ID 351 switch. The function of the ID 351 switch is to give the Co-pilot course selection control over the Pilot's course selector. The bottom of the center console contains a military type transponder. Simply dial in the transponder code, using the right most four digits of the thumb wheel.

Next to the floor there is a plexiglass covered set of buttons that you will not use. These switches are used to shut off the simulator in the event of a malfunction or power shortage. We have similar switches outside at the instructor panel which would be used if necessary.

The control yoke has three items of importance. First, a beehive shaped knob controls both elevator and aileron trim. The rudder trim control is located on the center console. All three trim guages are on the top front panel to the right of radios. There is a red emergency disconnect button on the control yoke for runaway trim which is non-functional. Both control yokes also have a nose wheel connect/disconnect button. As you will see in the checklist, you will disconnect nose wheel steering during the take off roll at 60 knots. Press this button now to disconnect and notice that the disconnect lights are the green lights on the top center panel. As would be expected, depressing this button in flight will not work as the relay is triggered by a squat switch on the main gear.

The last button on the control yoke is simply a push-to-talk button.

It is a two-position switch for intercom and ATC. We have wired it so that the intercom is always hot. You do need to depress the button for ATC.

This completes your cockpit orientation. If you have no further questions, you are ready to fly.

APPENDIX B: ATC Script

SCRIPT FOR OSU/NASA FLIGHT SCENARIO FROM MILWAUKEE TO MINNEAPOLIS

May 12, 1984

Segment	Freq	Communication	Instructions for ATC Person	Problem Indication	Probable Response
Preflight Checklist		NONE	Set and wind clocks in T-40		
ATIS	126.4	Mitchell Field Information B: Ceiling 400 OVC Vis 1/2, fog Temp 34, Dew point 33. Wind 340 @ 5. Altimeter 29.75 Landing and departures on RWY 1. IFR departures contact Clearance Delivery 120.0 prior to engine start. On initial call advise you have BRAVO	Set Temp at 0 deg C Set Wind at 340 @ 5 Set Altimeter at 29.87 Set Field Elevation at 723 Check Altitude in T-40 Set Fuel at 3600#s per tank		
Clearance Delivery	120.0	"Sabreliner 40RJ, cleared to MSP as filed. Maintain 8000 Exp Fl 280 10 min after Dep. Dep Freq. 119.3 Squawk 4330. GND Point 9 when ready to taxi.	Pilots should call prior to eng start. Pilot will read back clearance. Correct if necessary.		
Eng Start Checklist					
Call for Taxi on Ground Cont	121.9	"Sabreliner 40RJ, Taxi to RWY 1, TWR 119.1 when ready."	Crew should expect this from briefing		
Takeoff Call for TO Clearance	119.1	"Sabreliner 40RJ, Cleared for TO Fly RWY HDG"	Push: POSITION RESET just before takeoff.		
After lift off		"40RJ Contact Departure. Have a nice flight!"	BE ALERT: turn them over to departure as soon as they are off the ground		

CLIMB	119.3	"Sabreliner 40RJ Milwaukee Departure, Radar contact, continue climb to FL 230, fly Hdg 310 direct Badger on course."	
10,000		"Sabreliner 40RJ Contact Chicago center 125.1"	*** Set Wind at 135 deg at 80 kts ***
Chicago Ctr (low)	125.1	"Sabreliner 40RJ, Chicago Center continue climb to FL280 - proceed direct Nodine when able."	
17,000		"Sabreliner 40RJ, Contact Chicago center 126.0.	
Chicago Ctr (high)	126.0	"Sabreliner 40RJ, Chicago Center, report reaching FL 280"	

After reaching FL280:

Set MSP Approach Area as Follows:

X-Y Coordinates: Up=37200, Right=23560

CRUISE FL 280			MSP ATIS Weather on 135.35: MSP INT'l airport info X, measured ceiling 600 overcast, vis 2, fog, temp 34, dew point 33 wind 020 @ 5 alt 29.75. IFR arrivals expect ILS RWY 4. On initial contact indicate that you have information X."
at HILRO		"Sabreliner 40RJ Contact Minn Ctr 128.6"	
Minn Ctr	128.6	"Sabreliner 40RJ, Minn Center, FL280"	

CHI/Minn Boundary			*Fail Left Engine* *Fail GS* (Pilots will try to correct problem)	GEN out light Oil Pres LOW Loss of Alt Fuel flow drop	Crossfeed ON Add Power Airstart attempt Discuss divert Retrim A/C Report prob to ATC

After they are navigating on NODINE:

Cards: Card "Minneapolis Area" in Reader 1

	128.6	"Sabreliner 40RJ understand you have an engine failure. Advise intentions."	They should continue to MSP	No immediate indication	NONE for now
DESCENT (at Nodine)	128.6	Sabreliner 40RJ, descend and maintain 12,000 MSP Altimeter 29.75, Turn right Hdg 310; this will be radar vectors to Farmington.	Minn ATIS given above Give radar vectors as needed Direct them to Farmington as the initial approach fix. Direct them via radar vectors to enroute/approach change over point - 36 DME NW of Nodine before changing to Approach scale.		

At Troll Intersection: 36 DME NW of NODINE VOR

Set MSP Approach Area as follows:

Function: APP
Trainer Controls: POSITION RESET
Switch box: LOC ON
Replace X-Y Chart with MSP IFR Local

PAUSE			
	128.6	"Sabreliner 40RJ, Contact MSP Ctr 132.35."	
Minn Center (low)	132.35	"Sabreliner 40RJ, MSP Center, you are cleared direct Farmington. Descend and maintain 4,000."	RADAR Vector to TROLL XN.

Over Farmington (OR 10,000')	132.35	"Sabreliner 40RJ, Contact MSP App on 119.3"	*** Change wind to 020/5 ***		
APPROACH	119.3	"Sabreliner 40RJ, MSP Apch, fly hdg 300 deg to intercept the ILS RWY 4 Localizer, continue descent to 4,000"		Should notice GS inop	Discuss Alternatives Ask Appr about GS Report prob to App Determine new App Minimums
8 Miles after Farmington	119.3	"40RJ, turn right heading 360, intercept the localizer, Cleared for the ILS RWY 4 approach, maintain 4,000 until intercepting the localizer, Contact TWR 126.7 at the outer marker"			
LANDING					
Outer Marker	126.7	"Sabreliner 40RJ, MSP Tower, Cleared to land RWY 4, Wind 020 at 5. Would you like any emergency equipment?"			
After reaching 1260 feet and 2 min.			Tell the pilots that they may land straight ahead.		

Updated MAY 12, 1984
R.S. Jensen

PILOT BRIEFING

1. Tell pilots that the flight will be a normal corporate flight from Milwaukee to Minneapolis
2. Give pilots the *weather information*
3. Give pilots the filled out flight plan form
4. Give pilots the T-40 performance information for review
5. Give pilots enroute and approach charts
6. Tell pilots they should enter the cockpit to do their planning
7. *Review setup of avionics in cockpit before they start their planning*

T-40 SIMULATOR SETUP:

At OSU for Columbus Area (FAM Flight)

1. X-Y Coordinate: UP=41070, Right=56500
2. Cards: Card "Cols Area" in Reader 1
   Card "TVT, APE ref. for Col's " in Reader 2
3. Approach Station Selector (on Card Reader): 21
4. Function: APP
5. Place Columbus Area Chart on X-Y Plotter
6. Trainer Controls: POSITION RESET

At MSP for Minneapolis Area FAM

1. Up=44700, Right=13200
2. Card "Minn-St Paul Approach" in Reader 1
3. Card "*Milwaukee-Minn #2*" *in Reader 2*
4. Same
5. "
6. MSP Local Chart on Plotter
7. Same

At General Mitchel Field (Experimental Flight)

1. X-Y Coordinates: UP=22000, Right=61600
2. Cards: Card "Milwalkee - Minn #1" in Reader 1
   Card "Milwalkee - Minn #2" in Reader 2
3. Approach Station Selector (on Card Reader): 21
4. Function: IP
5. Place Enroute Chart in X-Y Plotter
6. Trainer Controls: POSITION RESET
7. Simulator Set up:

   a. Mount door on Simulator
   b. Mount camera on door

      1) Connect 10 pin camera connector to recorder
      2) Connect tape drive to tuner/power supply (Should be connected)
      3) Connect power cord to outlet on trainer base
      4) Connect white cable from Sony monitor to VHF "out to TV" on tuner/power supply
      5) Connect grey cable from mike mixer to "MIC" on tape drive
      6) "Display" switch on back of camera: ON

   c. Turn on recorder as follows:

      1) Recorder power on (on tuner/power supply)
      2) VCR/TV switch on (on tuner/power supply)
      3) Camera remote on (on tape drive)
      4) Camera display switch on (on camera back - should be on)
      5) Depress WB button on front of camera until WB indicator light turns green and stops flashing (Light is in camera viewfinder - should be on)

   d. Turn on Mike Mixer as follows:

      1) Connect pilot and copilot mikes to mixer (should be connected)
      2) Turn on MIXER.
      3) Test headsets and Mikes for transmittal and sound level.

At Troll XN for MSP Area (Experimnetal Flight)

1. X-Y Coordinates: UP=37200, RIGHT=23560
2. Cards: Card "Minneapolis Area" in Reader 1
3. Card "Milwakee - Minn #2" in Reader 2
4. Approach Station Selector (on Card Reader): 21
5. Function: APP
6. *Place MSP Area Chart in Plotter*
7. Trainer Controls: POSITION RESET

e. Complete Power on (these steps should be already done)

1) Connect audio input cable to Y adapter at recorder
2) Connect controller audio input to Y adapter at recorder
3) Connect 25' white 75 omm cable to Sony 75 omm input and to 75 omm output at recorder
4) Turn Sony power on
5) Set channel to 3 on TV Monitor

f. Computer Set up (See Computer Notebook)

1) Set T-40 Altimeter and field elevation.
2) Power switch at back of terminal on
3) Log on:

a) Type: Hel 210,2
b) Type: @DATA
c) Type: RUN [200,1]SIMULATOR
d) Answer questions
e) For help type: HELP SIMULATOR

3) When pilots enter T-40, turn camera switch on and flip toggle switch on switch box marked "1 DA" and watch for timer to start on Sony and the words "sampling has begun" on computer screen.
4) Toggle switch "2 EF" is flipped down at the engine failure
5) Toggle switch "3 LOC" is flipped down after setting up the Minn Local App Area
6) After the landing at Minn, data is stopped by flipping all three switches up.

g. Computer Shut down

1) Turn Camera Switch Off
2) Flip three toggle switch on switch box to up and watch for the words on the terminal to indicate that sampling has stopped. The Menu should appear.
3) Answer questions
4) Follow shut down procedure on SIMULATOR.DOC (Jeff's Simulator Instructions).

h. T-40 Shut down

1) Set Transponder to 1200
2) Remove cards from card reader - place in appropriate slot in right upper drawer.
3) Be sure to turn Mike Mixer - OFF.

i. Camera/Video Tape Recorder shut down

1) Reverse order of set up
20 Be sure to record time on tape at end of session

PILOT DEBRIEFING:

A. Have pilots fill out debriefing form
B. Discus details of experiment
C. Tell pilots not to reveal details of study to other pilots

APPENDIX C: Personal Attributes Questionnaire

PERSONAL CHARACTERISTICS INVENTORY

NAME______________________________ SOCIAL SECURITY NUMBER_______________

These items below inquire about what kind of a person you think you are. Each item consists of a pair of characteristics, with the letters A-E in between. For example:

Not at all Artistic	A.....B.....C.....D.....E	Very Artistic

Each pair describes contradictory characteristics -- that is, you cannot be both at the same time, such as very artistic and not at all artistic.

The letters form a scale between the two extremes. You are to choose a letter which describes where you fall on the scale. For example, if you think you have no artistic ability, you would choose A. If you think you are pretty good, you might choose D. If you are only medium, you might choose C, and so forth. Circle the letter that best describes you. Be sure to answer every question.

1.	Not at all aggressive	A.....B.....C.....D.....E	Very aggressive
2.	Very whiny	A.....B.....C.....D.....E	Not at all whiny
3.	Not at all independent	A.....B.....C.....D.....E	Very independent
4.	Not at all arrogant	A.....B.....C.....D.....E	Very arrogant
5.	Not at all emotional	A.....B.....C.....D.....E	Very emotional
6.	Very submissive	A.....B.....C.....D.....E	Very dominant
7.	Very boastful	A.....B.....C.....D.....E	Not at all boastful
8.	Not at all excitable in a major crisis	A.....B....C.....D......E	Very excitable in a major crisis
9.	Very passive	A.....B....C.....D......E	Very active
10.	Not at all egotistical	A.....B.....C.....D.....E	Very egotistical
11.	Not at all able to devote self completely to others	A.....B.....C.....D.....E	Able to devote self completely to others

GO TO NEXT PAGE

12.	Not at all spineless	A.....B.....C.....D.....E	Very spineless
13.	Very rough	A.....B.....C.....D.....E	Very gentle
14.	Not at all complaining	A.....B.....C.....D.....E	Very complaining
15.	Not at all helpful to others	A.....B.....C.....D.....E	Very helpful to others
16.	Not at all competitive	A.....B.....C.....D.....E	Very competitive
17.	Subordinates oneself to others	A.....B.....C.....D.....E	Never subordinates oneself to others
18.	Very home oriented	A.....B.....C.....D.....E	Very worldly
19.	Very greedy	A.....B.....C.....D.....E	Not at all greedy
20.	Not at all kind	A.....B.....C.....D.....E	Very kind
21.	Indifferent to other's approval	A.....B.....C.....D.....E	Highly needful of other's approval
22.	Very dictatorial	A.....B.....C.....D.....E	Not at all dictatorial
23.	Feelings not easily hurt	A.....B.....C.....D.....E	Feelings easily hurt
24.	Doesn't nag	A.....B.....C.....D.....E	Nags a lot
25.	Not at all aware of feelings of others	A.....B.....C.....D.....E	Very aware of feelings of others
26.	Can make decisions easily	A.....B.....C.....D.....E	Has difficulty making decisions
27.	Very fussy	A.....B.....C.....D.....E	Not at all fussy
28.	Gives up very easily	A.....B.....C.....D.....E	Never gives up easily
29.	Very cynical	A.....B.....C.....D.....E	Not at all cynical
30.	Never cries	A.....B.....C.....D.....E	Cries very easily
31.	Not at all self-confident	A.....B.....C.....D.....E	Very self-confident

GO TO NEXT PAGE

32.	Does not look out for self, principled	A.....B.....C.....D.....E	Look out only for self, unprincipled
33.	Feels very inferior	A.....B.....C.....D.....E	Feels very superior
34.	Not at all hostile	A.....B.....C.....D.....E	Very hostile
35.	Not at all understanding of others	A.....B.....C.....D.....E	Very understanding of others
36.	Very cold in relations with others	A.....B.....C.....D.....E	Very warm in relations with others
37.	Very servile	A.....B.....C.....D.....E	Not at all servile
38.	Very little need for security	A.....B.....C.....D.....E	Very strong need for security
39.	Not at all gullible	A.....B.....C.....D.....E	Very gullible
40.	Goes to pieces under pressure	A.....B.....C.....D.....E	Stands up well under pressure

GO TO NEXT PAGE

PART II

The following statements describe reactions to conditions of work and challenging situations. For each item, indicate how much you agree or disagree with the statement, as it refers to your self, by choosing the appropriate letter on the scale, A, B, C, D, or E. When you have decided on your answer, circle the letter that best describes your attitude. There are no right or wrong answers.

41. I would rather do something at which I feel confident and relaxed than something which is challenging and difficult.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

42. It is important for me to do my work as well as I can even if it isnt't popular with my co-workers.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

43. I enjoy working in situations involving competition with others.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

44. When a group I belong to plans an activity, I would rather direct it myself than just help out and have someone else organize it.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

45. I would rather learn easy fun games than difficult thought games.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

GO TO NEXT PAGE

46. It is important to me to perform better than others on a task.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

47. I find satisfaction in working as well as I can.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

48. If I am not good at something I would rather keep struggling to master it than move on to something I may be good at.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

49. Once I undertake a task, I persist.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

50. I prefer to work in situations that require a high level of skill.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

51. There is a satisfaction in a job well done.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

52. I feel that winning is important in both work and games.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

GO TO NEXT PAGE

53. I more often attempt tasks that I am not sure I can do than tasks that I believe I can do.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

54. I find satisfaction in exceeding my previous performance even if I don't outperform others.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

55. I like to work hard.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

56. Part of my enjoyment in doing things is improving my past performance.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

57. It annoys me when other people perform better than I do.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

58. I like to be busy all the time.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

59. I try harder when I'm in competition with other people.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

GO TO NEXT PAGE

60. It is important for me to get a job in which there is opportunity for promotion and advancement.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

61. It is important to my future satisfaction in life to have a job or career that pays well.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

62. It is important to me to have a job or career that will bring me prestige and recognition from others.

A	B	C	D	E
Strongly agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Strongly disagree

Please check to see that you have answered all questions. Place the test in the envelope and return it to the secretary.

APPENDIX D: Debriefing Questionnaire

Pilot Number__________

Date________________

DEBRIEFING QUESTIONNAIRE

1. How do you think the simulator operated?

2. What options did you consider upon engine failure and GS inop?

3. What factors caused you to make your decision as you did?

4. How do you think you and the Captain/Copilot worked together?

5. How much sleep have you had in the last 24 hours?

6. What kind of a schedule have you maintained the last 24/36 hours?

7. How frequently do you make night trips with takeoff times after 11:00 PM?

8. Do you think that you are a "night person" - perform as well or better at night as you do in the day time?

9. Have you been under any kind of stress - physical or mental, feeling ill, taking any medication?

10. When was your last day off? How did you spend it?

11. How much have you flown with today's other cockpit crew member?

12. How well do you know the person you flew with today?

13. Are there any factors that you can think of that might have affected the way you worked with the other crew member?

14. The pilot flying the aircraft should verbalize his plans for maneuvers and should be sure that the information is understood and acknowledged by the other pilot.

Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly

15. It is important to avoid negative comments about the procedures and techniques of other crewmembers.

Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly

16. Overall, successful flightdeck management is primarily a function of the flying proficiency of the Captain.

Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly

17. The Captain should take control and fly the aircraft in emergency and nonstandard situations.

Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly

18. First Officers should not question the decisions or actions of the Captain except when they threaten the safety of the flight.

Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly

19. Captains should encourage their First Officers to question procedures during normal flight operations and in emergencies.

Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly

20. There are no circumstances (except total incapacitation) where the First Officer should assume command of the aircraft.

Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly

21. Casual conversation in the cockpit during periods of low workload can improve crew performance.

Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly

22. My decision making ability is as good in emergencies as in routine flying situations.

Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly

23. An effective pilot can leave behind personal problems when flying.

Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly

24. Pilots should feel obligated to mention their own psychological stress or physical problems to other flightcrew personnel before or during a flight.

Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly

THE EFFECTS OF FATIGUE ON COCKPIT COMMUNICATION AND RESOURCE MANAGEMENT

Debriefing Responses

QUESTION 1

Subj #	Response
013	Okay
025	Fair to well
026	Ok
029	Very sensitive
032	Simulator operation seems higher than <sic> normal work load
033	Fair
038	It was a good simulation but naturally no realisstic feel.
039	Good simulator but very touchy. Overcontrol very easy.
041	Good
044	Good
045	Good
046	Pretty good except there isn't an NDB signal and the heading for takeoff and landing (when on the runway is hard to keep straight <sic>
047	No answer
048	OK as far as I can tell
049	Good
050	There didn't seem to be any problems at all.
051	Not too bad of in pitch (roll).
054	I never flew a jet before, but it seemed sensitive to me.
056	Reasonably well once the required control pressures were determined.
057	Good as what to be expected once you had time in it. (HDI sticks)

QUESTION 2

013	Restart engine (several times): (descent and attempt to restart) shutdown, raise min on approach
025	Engine failure (1) flap setting on App GG MDA change possible 1 engine go around
026	speed Alt & MDA
029	OK weather at destination to maintain airspeed.
032	engine restart (1 time) GS inop use col only
033	engine failure was good. There was a little confusion on the glideslope failure because of not being familiar with the equipment.
039	restart. localizer or beacom approach.
039	LDC approach NDB approach with GS inop continue flight try relight with engine failure.
041	Eng. failure - what airport can we land it? wx considerations, etc. GS ino - Loc only appr.
045	Another airport relight / GS LOC approach, GS monitor on?
044	Another airport. Eng. relight GS Monitor
046	Refer to engine failure checklist and continue to MSP GS inop: localizer approach.
047	Weather (landing minimums) Hydraulic system operation. alternate destination, equipment opeeration with reduced electrical load.

048 Restarting alternate destinations, goo around to previously agreed alternate.
049 LND wt weather another approach not available if we missed.
050 Missed approach with ILS to runway 29L
051 Location of VFP wx at destination and departure points. LOC app minimums
056 Checking wx at destination or most suitable airport in point of time, we had GS inop LOC only minimums.
057 1 as co-pilot followed capt. orders and offered advice after (crisis situation over with)

QUESTION 3

013 aircraft flies better on two. After descent and start of approach, we just flew the A/C regulations require min. increase
025 Lose of Eng. & GS
026 App plates
029 Nearly time for normal descent to airport weather ok
032 engine restart to confirm engine failure we were on and established for rny 4 KS only logical to continue using LOC min.
033 engine restart was a good possibility totry since there was no fire or apparent reason for failure.
035 It is what I would have done had it been an actual appr.
039 fuel load approaches available flight conditions
041 MSP was closest suitable airport
045 Weather at other airports and into ILS on rwy 4.
044 No other apparent choices.
046 Atis weather was above MDA for LOC approach.
047 Area weather all IFR destination wx above landing minimums. Good engine out performance.
048 Various flight conditions.
049 Weather was not bad and aircraft was operating well on one engine. Lots of power and fuel left if we missed annd could go try the ILS 29L.
050 Weather was 60 Z with non-precision that seemed ok.
056 Wx and distance to destination.
057 Following check list and command of PIC then I put my 2 cents in.

QUESTION 4

013 not at all
025 very well
026 very well
029 OK
032 well
033 very well
038 very well
038 very well
041 good
045 good
044 good
046 good for not knowing aircraft systems.
047 very well for not knowing simulator procedures very well.
048 very well

049 very good
050 just fine; co-pilot was helpful.
051 well
056 I was pleased with the overall crew crew coordination since we had not flown together in a jet.
057 very well

QUESTION 5

013 6 1/2 hrs
025 10 hrs
025 6 hrs
029 5
032 7 hrs
033 7 hrs
038 5 hrs
039 6 hrs
041 7 hrs
045 6 hrs
044 5 hrs
046 7 1/2 hrs
047 6 1/2 hrs
048 6.5
049 8 hrs
050 8 hrs
051 6 hours
056 6 1/2 - 7 hrs
057 8 hrs

QUESTION 6

013 easy not working now
025 heavy
026 8 hrs rest 16 hrs duty/20 hrs duty 16 hrs rest
029 office work - planning recurrent training
032 total 18 hrs work 7 hrs sleep 5 leisure
033 op at 6:00 a.m. work & school to 9:30 p.m. long days the school is a temporary item (cram courses)
038 off
039 rest
041 Dec. 12, 13 off Dec 14 (flew A-7 in A.M.)
045 13 hr day on 1/31/85 6 hrs sleep last night
044 early takeoff yesterday
046 have been on vacation. Taking it easy, no flying
047 worked 12 p.m.-8 p.m. sleep 12 a.m.-6:30 a.m. reading 8 p.m. - 12 a.m.
048 normal
049 a little less sleep than normal helped a friend move to ATL and drove 22 hrs without rest.
050 off Sunday 24 hrs. 12:00 - 0800 sleep drove 2 1/2 hrs prior to flight
051 heavy
056 Hectic to say the least. Many time demand functions
057 rest period

QUESTION 7

029	1-2 times per month
041	7 times a month
045	very few
044	very seldom
046	very rarely
047	5-6 times a month
048	never
050	not frequently at all
051	15%
057	about 1/4 of the time

QUESTION 8

029	No - a day person
041	if you're absolutely rested
045	no
044	not necessarily
046	no
047	yes
048	no
049	about the same
050	don't perform as well after 0100. Up to that seems to be fine
051	yes yes
056	no
057	yes

QUESTION 9

013	no
025	no physical stress above average to average mental stress no medication
026	A bit of mentala stress
029	slightly tired - lack of sleep
033	No
038	looking for a full time job
039	no
041	none
045	no
044	no
046	no
o47	mental stress wife with illness
048	no
050	taking courses. 12 hrs graduate study - final exams last week. Hernia operation 6 weeks ago. Just returned to flight status.
051	No
056	mental stress
057	no

QUESTION 10

013	yesterday (unemployed) reading, working with home computer, exercise.
025	over 15 days ago working at home
026	4 May 84 mowing grass
029	Sunday 12-9-84
032	Sunday 5-6-84 Yard work
033	Sunday a week ago, 9 days ago I spent it with my family
038	yesterday - working around the house
039	yesterday watching TV
041	yesterday
045	1/29/84 went ice fishing, did very well, too
044	2 days ago I did freelance Ak maintenance
046	9/22/84 changed the oil in my truck and washed it and did 3 sets of Jeppsens
047	5 days ago spent working at home
048	yesterday litigation (won!!!)
049	Sunday 11/24/84 sitting at ATL airport trying to get home
050	11/25 Sunday - Church/relaxing TV/Church in evening
051	4 days ago at home sick
056	yesterday - between 7:30 a.m. and 9:30 p.m. I made stops at 16 points within the city
057	yesterday Wednesday

QUESTION 11

013	0 (zero)
025	300 hrs +
026	300 hrs +
029	None
032	600 hrs +
033	2 years
038	very little
039	zero (0)
041	None
045	100 hrs
044	150 hrs
046	100 hrs
047	100 hrs
048	never
049	500 hrs
050	500 hrs in Merlin III
051	never
056	45 minutes
057	only once in turbo arrow about 45 minutes

QUESTION 12

013	Fine
025	Fair to well
026	Good
029	Never met before
032	we work well together

033	good
038	very good
039	excellent
041	Met on day of flight
045	pretty well
044	well
046	good We fly together as much as any crew at our company.
047	Worked at same establishment for 4 yrs.
048	Fairly. He is my instructor. 15 hrs total conversation
049	good friends
050	very well about 7 years
051	as a simulator student - not very
056	Fairly well - good communication report 4 yrs
057	Only flew with him once but have good discussions with him on several occasions.

QUESTION 13

013	Neither one of us knew enough about the A/C to fly without using the checklist
025	Disagreement with Co-pilot within the last 3 days
026	No
029	question left blank
032	No
033	Lack of familiarity with the equipment
038	No
039	The knowledge a friendship made working easier. The past experience of both makes thinking similar in similar circumstances.
041	not working together before
045	no except positive
044	no
046	I wasn't as sharp as I should have beenn because of being on vacation, I haven't flown in 7 days.
047	not very familar with this aircraft and cockpit procedures
048	not answered
049	no
050	If other crewmember is making mistakes or I don't trust him. Not the case here.
051	no
056	additional crew coordination briefing
054	If (unreadable) it might make me feel uneasy and therefore have a lot more fatigue.

QUESTION 14

013	
025	Ag Str
026	Ag Str
029	A Sli
032	Ag Str
033	A Str
038	A Str
039	A Sli

041	A Sli
045	A Str
044	A str
046	A str
047	A Str
048	D Str
049	A Str
050	A Str
051	A Str
056	A Str
057	A Str

QUESTION 15

025	Di Str
026	Di Sli
029	New
032	Di Str
033	Neu
038	A Sli
039	A Str
041	D Sli
045	A Sli
044	A Sli
046	A Sli
047	A Sli
048	answered verbally
049	A Str
050	D Sli
051	A Str
056	A Str
057	D Str

QUESTION 16

025	Neu
026	Ag Sli
029	A Sli
032	Di Str
033	A Sli
038	D Sli
039	D Sli
041	A Sli
045	D Str
044	D Str
046	Nev
047	D Sli
048	D Str
049	D Str
050	D Sli
051	D Sli
056	D Sli
057	D Sli

QUESTION 17

025	Ag Str
026	Ag Sli
029	A Sli
032	Di Str
033	A Str
038	A Sli
039	Neu
041	D Sli
045	Nev
044	Nev
046	A Sli
047	A Sli
048	D Str
049	D Str
050	Nev
051	Nev
056	D Sli
057	D Sli

QUESTION 18

025	Ag Sli
026	Ag Sli
029	D Sli
032	Di Str
033	A Sli
038	A Str
039	D Str
041	D Str
045	A Sli
044	A Sli
046	Nev
047	A Sli
048	A Sli
049	D Sli
050	D Str
051	D Sli
056	D Str
057	D Sli

QUESTION 19

025	Ag Str
026	Ag Str
029	A Sli
032	Ag Str
033	Nev
038	A Str
039	D Sli
041	A Str
045	A Sli
044	A Sli

046	A Str
047	A Str
048	A Str
049	A Sli
050	A Str
051	A Str
056	A Str
057	A Sli

QUESTION 20

025	Di Str
026	Nev
029	A Sli
032	Di Str
033	Nev
038	D Str
039	D Str
041	D Str
045	D Sli
044	D Str
046	D Str
047	A Sli
048	D Str
049	A Sli
050	D Str
051	A Sli
056	D Sli
057	Nev

QUESTION 21

025	Nev
026	Ag Str
029	A Sli
032	Ag Sli
033	A Str
038	A Sli
039	A Str
041	A Sli
045	A Sli
044	A Sli
046	Nev
047	Nev
048	A Sli
049	A Str
050	A Str
051	A Str
056	A Sli
057	A Sli

QUESTION 22

025	Nev
026	Ag Sli
029	A Sli
032	Ag Sli
033	Nev
038	A Str
039	D Sli
041	A Str
045	D Sli
044	A Sli
046	A Sli
047	A Sli
048	D Str
049	A Str
050	A Str
051	A Sli
056	A Sli
057	A Sli

QUESTION 23

025	Dis Str
026	Ag Str
029	A Sli
032	Dis Sli
033	A Sli
038	A Sli
039	D Sli
041	A Sli
045	A Sli
044	A Sli
046	A Str
047	A Sli
048	A D Str
049	A Sli
050	D Sli
051	Nev
056	A Sli
057	A Str

QUESTION 24

025	Ag Str
026	Ag Str
029	Nev
032	Ag Sli
033	Nev
038	A Sli
039	A Sli
041	Nev
045	D Str
044	A Sli

46	A Str
047	A Sli
048	D Str
049	A Str
050	A Sli
051	Nev
056	A Str
057	A Str

APPENDIX E: Various other Subject Questionnaires

THE OHIO STATE UNIVERSITY Protocol No. 79B0069

CONSENT FOR PARTICIPATION IN
SOCIAL AND BEHAVIORAL RESEARCH

I consent to participating as a pilot in NASA/OSU research to investigate cockpit workload and resource management in a T-40 flight simulator. I understand that the simulator cockpit environment will be video taped for use by the researchers to document ATC procedures, cockpit workload and instrument readings. Upon completion of this research project, by mutual agreement with NASA and OSU, the video tape will be erased.

Dr. Jensen, the Principal Investigator, or his authorized representative has explained to me the purpose of the study, the procedures to be followed, and the expected duration of my participation. Possible benefits of the study have been described as have alternative procedures, if such procedures are applicable and available.

I acknowledge that I have had the opportunity to obtain additional information regarding the study and that any questions I have raised have been answered to my full satisfaction. Further, I understand that I am free to withdraw consent at any time and to discontinue participation in the study without prejudice to me. The information obtained from me will remain confidential unless I specifically agree otherwise by placing my initials here ________.

Finally, I acknowledge that I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me.

Date: ________________ Signed: ______________________________
Participant

Signed: Richard S Jensen
(Principal investigator or his/her
Authorized Representative)

Witness: ______________________________

T-40 PERFORMANCE INFORMATION

ASSUMPTIONS:

Takeoff Weight = 17,000
Landing Weight = 15,000
Runway Length = 9,000
Runway Condition - GOOD

Gear Speed: 180kts
Flap Speed: 180kts
Approach Flaps (66%) ok @ 225kts

TAKEOFF:

V1 = 109kts
Vr = 119kts
V2 = 125kts

Pitch Attitude: 12 degrees up to 3,000 feet AGL
Then approx. 8 deg

CLIMB:

240kts to 10,000 feet
270kts to Mach .64
Mach .64 to Cruise Altitude

NOTE: Pt5 indicates total pressure at turbine blade #5.
Pt5/Stand Press = EPR

CRUISE:

Set Power for Mach .77 at FL280

APPROACH:

Initial Approach: 175kts (flaps extended and gear down prior to intercepting final approach course)

Final Approach: 135kts (Set power at approx. 75% RPM)

LANDING:

115kts

POWER:

Takeoff and Climb = 100% RPM
Cruise = approx. 91% RPM (Set to Mach .77)
Descent = as required

TACAN Channels:

APE	114	BAE	111	MCW	96
TVT	112	ODI	126	FOD	82
ZZV	51	FGT	104	ONL	86
		GEP	120		

Pilot Number__________

Date__________________

BIOGRAPHICAL INFORMATION

NAME______________________________

ADDRESS___________________________

____

____

PHONE_____________________________

AGE_____________SEX______________

CURRENT EMPLOYER AND POSITION__________________________

____

FLYING EXPERIENCE

Flight Certificates and Ratings____________________________

Total Flight Time____________________________

Total Flight Simulator Time____________________________

Flight time in last 6 months____________________________

Total Turbine Time (Pilot + Copilot)____________________________

Turbo Prop Time (Pilot + Copilot)____________________________

Turbine Time as Captain____________________________

Cockpit Position Most Commonly
Held during the Past Year - - - Pilot______ Copilot______

Type of Flying Done Currently

Airline____________ Corporation____________

Charter____________ Flight Instruction____________

Personal___________ Other________________

Military Flying Total Time____________________________

WEATHER SEQUENCE REPORTS

ORD SA 1456 W1 X 3/4 BS 049/32/30/0110/968

MKE SA 1448 M2 X 1/4 BS 025/34/33/3405/987

MADISON

MSP SA 1451 M3 OVC 1/2 BS 085/32/31/3510/987

MSN SA 1446 E1 OVC 1/4 BS 038/30/28/0910/965

LSE SA 1455 M2 OVC 1/4 S 075/30/28/3510/975

AUW SA 1452 M3 OVC 2 R 083/36/35/3605/978

CBG SA 1450 M4 OVC 3/4 RBS 091/34/33/3610/980

SUX SA 1450 M12 OVC 5R 115/35/29/3315/977

EAU SA 1449 M1 OVC 1/4S 117/30/29/3410G20/988

DLH SA 1450 M8 OVC 6 120/22/15/3215/989

TERMINAL FORECASTS

MSP FT 101515 C3 OVC 1/2 3510. 18Z C5OVC 1BS 3315.
21Z C8 OVC 2BS 33515 09Z IFR.

MKE FT 101515 C2X 1/4 BS 1810. 18Z C3X 1/2 BS 2415.
21Z C4 OVC 1/2 BS 2720. 09Z IFR.

SUX FT 101515 C7 OVC 5R 3315
21Z C12 OVC 3520. 09Z VFR.

ORD FT 101515 C 3X 3/4 0110. 18Z C8OVC 1 1/2 R 3515.
21Z C8 OVC 2 R 3320. 09Z IFR.

WINDS ALOFT FORECASTS

	3000	6000	9000	12000	18000	24000	30000	34000	39000
DSM	2620	2230-12	2235-17	2038-23	1847-34	1763-48	158558	169471	740377
GRB	1920	2125-12	2325-17	2035-22	2044-35	1660-45	147857	179372	741374
MSP	3315	2430-11	2230-18	2034-23	2039-37	1657-48	138058	129575	740977
ORD	0215	2625-13	2432-19	2237-24	2043-36	1660-48	128560	139873	741075

APPENDEX F: KLM Communication Coding Questionnaires and Data

KLM Communication Coding Forms and Data

The KLM Crew Management Course administered by Interaction Trainers, Ltd. of England includes an impressive technique for coding communication data called "Behavioral Analysis." This technique identifies 13 catagories of communication behavior as shown in the observer form called "Cockpit Communication Workload" presented on Page F-2. Definitions of these categories are shown on Page F-3. Pages F-4 and F-5 present an interpretation of the ratios of each category that represent effective cockpit communication behavior. Table F-1 presents the results of a communication behavior coding effort from a simulator LOFT scenario run in a Boeing 737. Finally, Page F-6 is a proposed coding scheme for categorizing cockpit communication data in terms of Transactional Analysis, another model of communication behavior taught in the KLM course.

Table F-1. Communication Numbers for Each of the Behavioral Categories Observed during a LOFT scenario.

Category	Flight Segment					
	Prefit Cpt F/O	Startup Cpt F/O	Takeoff Cpt F/O	Descent Cpt F/O	Landing Cpt F/O	Total Cpt F/O
Reacting						
Supporting	3,1	1,3	4,2	7,	,1	15,7
Disagreeing	1,	1,	3,2			5,2
Defend/Attack						0,0
Blocking						0,0
Open				1,		1,0
Total	4,1	2,3	7,4	8,0	0,1	21,9
Commanding						
Immediate	13,	8,	21,3	13,6	1,	58,9
Deferred	2,		2,	2,		6,0
Total	15,0	8,0	23,3	15,6	1,0	62.9
Infor Processing						
Giving Expl		3,2	2,1	,1		5,4
Giving Ops Info	32,11	1,	6,4	16,10	4,3	[illegible]
Giving Info	11,7	21,5	14,14	1,1		47,27
Asides	6,4				2,1	8,5
Checking	30,30	15,15	6,14	,15	2,11	53,85
ATC	15	5,5	5,34	10,12	,4	20,70
PA	11,			7,		18,0
Total	90,67	45,27	33,67	34,45	8,19	210,205
Questioning						
Seeking Info	5,	2,1	2,1	4,		13,2
Testing Und	3,2	,1	2,2	5,4		10,9
Testing Und-Sim			1,			1,0
Total	8,2	2,2	5,3	9,4	0,0	24,11
Overall Total						317,254

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COCKPIT COMMUNICATION
WORKLOAD

TYPE.................CREW........

ROUTE................DATE........

A/N										
	Pre-flight	Start-up	Taxi	Take-off	Climb-out	Cruise	Descent	Landing	Taxi	Shut-down

	CATEGORIES		CAPTAIN	CO-PILOT	FLIGHT ENG.	CABIN	ATC	GRD.	TOT.
REACTING	Supporting								
	Disagreeing								
	Defend/Attack								
	Blocking/Diff								
	Open								
COMMANDING	Directing	Immediate							
		Deferred							
INFORMATION PROCESSING	Giving Expl								
	Giving Op Info								
	Giving Info								
	Asides								
	Checking								
	Broadcast	ATC							
		PA							
QUESTIONING	Seeking Info								
	Testing Und								
	Testing Und-Sim								
ACTING	Physical Action								
	Totals								

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VERBAL BEHAVIOUR CATEGORIES

PROPOSING PR	Behaviour which puts forward a new concept, suggestion or course of action (and is actionable).
BUILDING BU	Behaviour which extends or develops a proposal which has been made by another person (and is actionable).
SUPPORTING SP	Behaviour which involves a conscious and direct declaration of support or agreement with another person or his concepts.
DISAGREEING DS	Behaviour which involves a conscious, direct and reasoned declaration of difference of opinion, or criticism of another person's concepts.
DEFENDING/ ATTACKING DA	Behaviour which attacks another person or defensively strengthens an individual's own position. Defending/attacking behaviours usually involve explicit value judgements and often contain emotional overtones.
BLOCKING/ DIFFICULTY STATING BD	Behaviour which places a difficulty or block in the path of a proposal or concept without offering any alternative proposal and without offering a reasoned statement of disagreement. Blocking/difficulty stating behaviour therefore tends to be rather bald; e.g. "It won't work", or "We couldn't possibly accept that".
OPEN OP	Behaviour which exposes the individual who makes it to risk of ridicule or loss of status. This behaviour may be considered as the opposite of defending/attacking, including within this category admissions of mistakes or inadequacies provided that these are made in a non-defensive manner.
TESTING UNDERSTANDING TU	Behaviour which seeks to establish whether or not an earlier contribution has been understood.
SUMMARIZING SU	Behaviour which summarizes, or otherwise restates in a compact form, the content of previous discussions or considerations.
SEEKING INFORMATION SI	Behaviour which seeks facts, opinions or clarification from another individual or individuals.
GIVING INFORMATION GI	Behaviour which offers facts, opinions or clarification to another individual.
SHUTTING OUT SO	Behaviour which excludes, or attempts to exclude, another group-member (e.g. interrupting, talking over).
BRINGING IN BI	Behaviour which is a direct and positive attempt to involve another group-member.

SUMMARY OF INTERPRETIVE FACTORS

Behaviours	Pop. Av.%	Guideline Ratios etc.	Notes
Proposing	12	2/1	These behaviours are about 'concern for action' yours and others. Building embodies implicit support and explicit proposal. To achieve 2/1 you are showing considerable interest in others' ideas.
Building	2		
Supporting Disagreeing Defend/Attack Blocking/Difficulty Stating Open	18	under 10% -low reaction over 20 % increases into High Reaction	Balance of supporting versus disagreeing + Defend/Attack will indicate additionally the overall reactive picture which is communicated. Relate to TU and SI. Ability to use open behaviour is important but too much can be as much of a problem as none at all.
Testing Understanding Summarizing	5	10%	Clarity of discussion is related directly to TU+SU. In a group much of this function is often delegated to one member.
Seeking Information	10	1/2	SI clarifies, GI can cause listening and thinking problems. 30% GI is an economical amount, the higher levels of GI reach 65%.
Giving Information	45		
Shutting Out	These usually occur with behaviours from the above list		Typical range 5 - 40%. Beware of judgements based on figures alone. Did the circumstances demand it?
Bringing In			Typical range 0 - 3%. This behaviour can be used in a wide variety of ways: to draw reaction, to involve a quiet person, to redirect the discussion and to express interest in others.

LOOKING AT BEHAVIOUR DATA

CATEGORIES	A		A's valid thoughts on looking at his own data.
PROPOSING	14	14 : 1	I seem to have put forward much more of own ideas without building on other peoples suggestions. How well does the proposing work? Would more building give any advantage?
BUILDING	1		
SUPPORTING	11	25.8% -	Reaction - seem to have reacted a lot, mainly in disagreeing ways. How appropriate was that in discussion? Had I a clear enough idea of others' views on which to react like this, or was I simply pressing for my own wishes? Could some more building have been done to useful effect?
DISAGREEING	10		
DEFENDING/ ATTACKING	2		
BLOCKING DIFFICULTY STATING	5		
OPEN	3		
TESTING UNDERSTANDING	1	-	Less than 1%, but a lot depends on how much other people were doing worth keeping an eye on.
SUMMARIZING	-		
SEEKING INFORMATION	11	5.6 : 1	If the discussion was messy perhaps more SI would have been useful. Certainly a lot of information was given and maybe more questions (SI) would reduce this level. Was the information significant in the discussion?
GIVING INFORMATION	62		
TOTALS for A,B,C,D,E respectively	120	158 83 61 166	How much did I say compared with the others? Too much? Too little? Would I have preferred it to have been different? If so, what would be the most useful change?
SHUTTING OUT	18	-	15% of behaviours were accompanied by shut out. How appropriate was it? What behaviour most frequently came with the shut out? What effect or consequence is it likely to have? How closely does that reflect everyday behaviour?
BRINGING IN	1	-	Not much there! Would more have been appropriate? What could have been gained from having more?

TRANSACTIONAL ANALYSIS

Subject:...............

Duration:.............

Source:................

Reference:............

		A		B		NOTES
LIFE POSITIONS		OK-OK	NOK-OK	OK-OK	NOK-OK	
		OK-NOK	NOK-NOK	OK-NOK	NOK-NOK	
PARENT	CRIT					
	NUR					
ADULT						
CHILD	NAT					
	ADAP					
	LITTLE PROF					
TOTALS		TOTAL A BEHAV.	% SHARE OF INTER.	TOTAL B BEHAV.	% SHARE OF INTER	TOTAL BEHAVIOURS IN INTERACTION

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